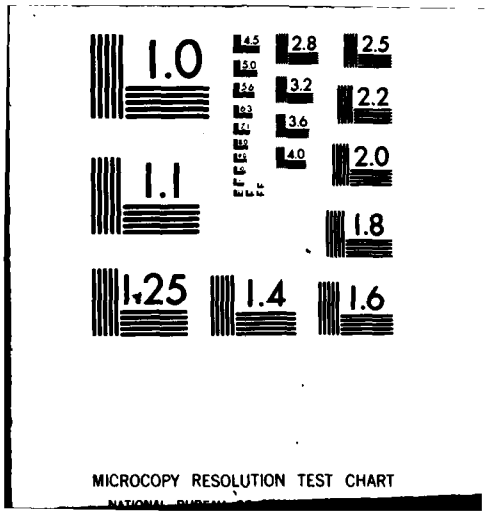
AD-A082 111 GAI CONSULTANTS INC MONROEVILLE PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. HAWSTONE DAM, (NDI NUMBER PA-C--ETC(U)
JAN 80 DACW31-80-C-0016
UNCLASSIFIED NL

END
DATE FILMED
4-80
DTIC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1
8.0
9.0
MICROCOPY RESOLUTION TEST CHART

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

ORIGINAL CO... COLOR PLATES: ALL DDC
REPRODUCTIONS WILL BE IN BLACK AND WHITE

DTIC
ELECTE
D

PREFACE

A

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topograhic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

A 23cp

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

Hawstone Dam: NDI I.D. No. PA-00580

Owner:	John Hostetter
State Located:	Pennsylvania (PennDER I.D. No. 44-7)
County Located:	Mifflin
Stream:	Unnamed Tributary to the Juniata River
Inspection Date:	26 November 1979
Inspection Team:	GAI Consultants, Inc. 570 Beatty Road Monroeville, Pennsylvania 15146

Based on a visual inspection, operational history, and available engineering data, the dam is considered to be in poor condition.

Deficiencies noted by the inspection team include: a) an overall lack of maintenance, b) spalled and delaminated concrete surfaces along both faces of the dam, c) leakage through the downstream dam face, d) extensive cracking of the spillway structure and, e) lack of drawdown capability.

The size classification of the facility is small and its hazard classification is considered to be significant. In accordance with the recommended guidelines, the range of the Spillway Design Flood (SDF) for the facility is the 100-year Flood to the 1/2 PMF (Probable Maximum Flood). Due to the potential for loss of life from sudden failure of the dam, the SDF is considered to be the 1/2 PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store about 39 percent of the PMF prior to dam overtopping. Thus, based on criteria contained in the recommended guidelines, the spillway is considered inadequate, but not seriously inadequate.

The structure is considered stable in its present configuration. However, because of the poor condition of the spillway, large discharges could possibly cause undermining

of the spillway structure and erosion at the toe of the dam which could result in structural failure. Thus, the facility is considered unsafe, non-emergency.

It is recommended that the owner:

a. Develop a warning system to minimize the potential for loss of life and economic damage downstream of the facility in the event of a dam failure. The system should include provisions for around-the-clock surveillance during periods of unusually heavy precipitation and a communications plan with appropriate highway and railroad personnel.

b. Provide the present outlet conduit with a blowoff valve or develop an alternate means of draining the reservoir.

c. Have the spillway assessed by a registered professional engineer experienced in design of concrete and hydraulic structures and take remedial measures required to adequately restore its function.

d. Have the deterioration and leakage observed on the downstream face of the dam assessed by a registered professional engineer experienced in the design of concrete structures and take remedial measures deemed necessary.

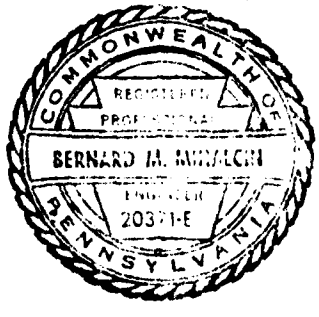
e. Have the spillway system evaluated by a registered professional engineer experienced in hydrology and hydraulics and take remedial measures necessary to make the spillway hydraulically adequate.

f. Develop formal manuals of maintenance and operations to ensure proper care of the facility.

GAI Consultants, Inc.

Bernard M. Mihalcin, P.E.

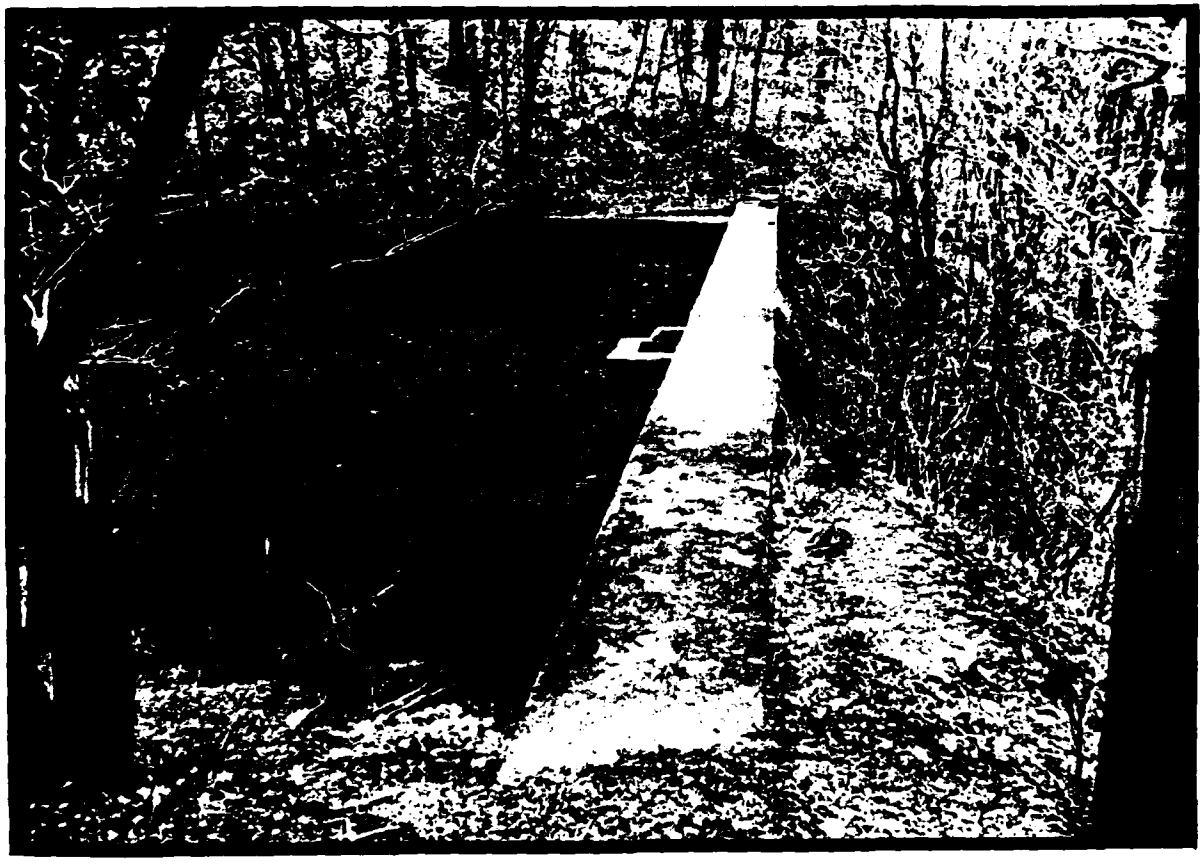
Date 12 FEB 1980



Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

DLB:BMM/sam DATE: 12 March 1980



OVERVIEW PHOTOGRAPH

TABLE OF CONTENTS

TABLE OF CONTENTS

(6)

NATIONAL DAM INSPECTION PROGRAM
HAWSTONE DAM,
(NDI# PA-00580, PENNDER[redacted] Number 44-71)

Number

Susquehanna River Basin, Tributary to Juniata River, Mifflin County, Pennsylvania. Phase I

1.0 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

(11) Jan 80 (12) 85

Inspection report.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

(15) DACW31-80-C-0016

1.2 Description of Project.

a. Dam and Appurtenances. Hawstone Dam is a concrete-gravity type structure approximately 34 feet high and about 157 feet long, including spillway. The spillway is an uncontrolled, rectangular, concrete chute channel located at the left abutment. The spillway crest is 17.4 feet long and has 3.1 feet of available freeboard. The facility is equipped with an 8-inch diameter cast iron pipe (CIP) supply main located near the right abutment. The supply line provides untreated domestic water to the nearby community of Hawstone, Pennsylvania. No means for draining the reservoir is presently available.

b. Location. Hawstone Dam is located in Granville Township, Mifflin County, Pennsylvania, 1 mile west of Hawstone, Pennsylvania on an unnamed tributary to the Juniata River. The City of Lewistown, Pennsylvania is located 5 miles west of the facility along Pennsylvania Route 333. The dam, reservoir, and watershed are located on the Lewistown, Pennsylvania U.S.G.S. 7.5 minute topographic quadrangle (see Figure 1, Appendix E). The coordinates of the dam are N40° 34.9' and W77° 31.8'.

c. Size Classification. Small (34 feet high, 6.5 acre-feet storage at top of dam).

d. Hazard Classification. Significant (see Section 3.1.e).

411002

e. Ownership. John Hostetter
R.D. 8
Gettysburg, Pennsylvania 15325

f. Purpose. Water supply.

g. Historical Data. Hawstone Dam was designed and constructed in 1920 by the Berkebile Brothers of Johnstown, Pennsylvania for the Haws Refractories Company. The purpose of the facility was to supply domestic and industrial water to the village of Hawstone, Pennsylvania, and the owner's nearby silica brick plant.

PennDER files contains information pertaining to the facility between 1920 and 1961. Correspondence and memorandum indicate the facility was inspected frequently by the state and was repaired, for the most part, in accordance with the various recommendations of state inspectors. The last formal inspection took place in 1961. Deficiencies noted at that time included: a) spalling of the downstream dam face, b) a deteriorated concrete spillway channel and, c) a spillway approach partially obstructed by trees and brush. The above deficiencies still exist today and apparently were never corrected.

There are no records available from PennDER after 1961. Discussions with local residents revealed that the Haws Refractories Company shutdown its Hawstone operations in September 1968 and the plant was subsequently razed. Ownership of the dam has since been transferred to John Hostetter of Gettysburg, Pennsylvania. Mr. Hostetter reportedly permits free use of the facility's water supply to the community; however, he provides no maintenance. Costs of maintaining the water supply are borne, when necessary, by the citizens of Hawstone.

1.3 Pertinent Data.

a. Drainage Area (square miles). 0.22

b. Discharge at Dam Site.

Discharge Capacity of the Outlet Conduit - Discharge curves are not available.

Discharge Capacity of Spillway at Maximum Pool ≅ 290 cfs (see Appendix D, Sheet 8).

c. Elevation (feet above mean sea level). The following elevations were obtained through field measurements based on the elevation of normal pool at 592 feet (see Appendix D, Sheet 2, Note 2).

Top of Dam	595.1
Maximum Design Pool	Not known
Maximum Pool of Record	Not known
Normal Pool	592
Spillway Crest	592
Upstream Inlet Invert	565
Downstream Inlet Invert	Not applicable
Streambed at Dam Centerline	560
Maximum Tailwater	Not known

d. Reservoir Length (feet).

Top of Dam	270
Normal Pool	250

e. Storage (acre-feet).

Top of Dam	6.5
Normal Pool	5.2
Design Surcharge	Not known

f. Reservoir Surface (acres).

Top of Dam	0.42
Normal Pool	0.37
Maximum Design Pool	Not known

g. Dam.

Type	Concrete-gravity.
Length	157 feet (including spillway).
Height	34 feet (field measured; crest to downstream toe).
Top Width	6 feet.
Upstream Slope	Vertical (upper 15 feet). 0.8H:10V (toe to 15 feet below crest).
Downstream Slope	Vertical (upper 9 feet). 6:25 H:10V (toe to 9 feet below crest).
Concrete Type	1:3:6 mix embedded with 20 percent one-man stones.

	Monolith Joints	Four key joints divide dam into 5 monoliths. Joints are spaced at 22, 51, 71, and 101 feet to the right of the spillway.
	Grout Curtain	None indicated.
	Cutoff	Foundation keyed into hard slate. Left abutment consists of 6-foot thick cutoff wall which extends to rock under the spillway slab.
h.	Diversion Canal and Regulating Tunnels.	None.
i.	Spillway.	
	Type	Uncontrolled, rectangular, concrete chute channel with a broad crest.
	Crest Elevation	592 feet.
	Crest Length	17.4 feet.
j.	Outlet Conduit.	
	Type	8-inch diameter CIP supply line.
	Length	1 mile (approximate distance to Hawstone).
	Closure and Regulating Facilities	None. Control was previously provided via valve reportedly located about 80 feet downstream of the dam. Valve was removed in October 1979 and replaced with standard pipe section.
	Access	None.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources. PennDER files contain design drawings and specifications along with a brief report entitled, "Data for Design of Hawstone Dam" by Berkebile Brothers, Engineers and Contractors, Johnstown, Pennsylvania (undated). The report considers conditions for the design of the dam cross-section including stability. Additionally, a state permit application report dated August 21, 1918 discusses design features of the facility in detail.

b. Design Features.

1. Dam. The dam is a gravity-type structure constructed of 1:3:6 mix concrete embedded with 20 percent one-man stone. The structure has a 6-foot top width. The downstream face is battered at 7.5 inches in 12 inches (6.25H:10V) to an elevation 9 feet below the crest, the upper 9 feet being vertical. The upstream face is battered at 1-inch in 12 inches (0.8H:10V) to an elevation 15 feet below the crest, the upper 15 feet being vertical (see Figure 4). A 6-foot thick cutoff wall extends from the gravity section into the left abutment under the spillway. The cutoff apparently is founded on rock but terminates in soil along the extreme left end.

Figure 3 shows the dam carried to a slate foundation across its length. Reportedly, the rock foundation is excavated to a depth of 4 to 5 feet with the bottom of the trench being stepped to offer greater sliding resistance. Additionally, several feet of earth backfill was apparently placed at the downstream toe.

2. Appurtenant Structures.

a) Spillway. The spillway is an uncontrolled, concrete, rectangular chute channel located at the left abutment. The crest is 17.4 feet long and is set 3.1 feet below the top of the wingwalls. The discharge channel follows the slope of the left abutment hillside, is 74 feet in length (see Figure 2), and is founded on soil.

b) Outlet Conduit. The outlet conduit consists of an 8-inch diameter cast iron supply pipe located about 40 feet from the right abutment. The inlet to the line is situated about 30 feet below the dam crest at the base of a concrete gate tower that abuts the upstream dam

face (see Figure 4). The original tower design provided for intakes at two different levels controlled via two 12-inch by 12-inch sluice gates located 16 and 30 feet below the crest. These gates, however, are no longer in place. Drawdown capability was originally provided by means of an 8-inch diameter gate valve located approximately 80 feet downstream of the dam. The valve was replaced in October 1979 with a standard pipe section. No alternate means of draining the reservoir is provided by the original design and, consequently, the facility has no current drawdown capability.

c. Specific Design Data and Criteria.

1. Hydrology and Hydraulics. No formal design reports or calculations are available. Correspondence contained in PennDER files indicates that the maximum design spillway capacity was reported to be 327 cfs based on a crest length of 18 feet and 3 feet of freeboard. This capacity was reported in 1918 to be "more than the expected runoff."

2. Dam. Design data and specifications are contained in PennDER files.

The following conditions were considered for the design of the cross-section.

I. Line of pressure for reservoir both full and empty must lie within the center third of the section.

II. The maximum pressure must not exceed 8 tons per square foot of masonry (note: dam was originally conceived as a masonry structure, but was eventually constructed of concrete).

III. The friction between horizontal sections and between the dam and its base must be sufficient to prevent sliding.

IV. Upward hydrostatic pressure on the base not considered.

V. Ice pressure not considered.

3. Appurtenant Structures. No specific design reports or calculations are available.

2.2 Construction Records.

Contract drawings, specifications, and several construction photographs are contained in PennDER files.

2.3 Operational Records.

No records of the present day-to-day operation of the facility are maintained.

2.4 Other Investigations.

Aside from periodic state inspections, no records of other formal investigations are available.

2.5 Evaluation.

The available data are considered adequate to make a reasonable Phase I assessment of the facility.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the facility indicates that the dam and its appurtenances are in poor condition.

b. Dam. The visual inspection indicates the dam is in poor condition. The upstream and downstream faces are extensively spalled and delaminated (see Photograph 3). Leakage emanates through a crack in the downstream face located approximately 60 feet from the right abutment and about 5 feet below the dam crest (see Photographs 2 and 4). The amount of seepage through the crack was slight and not measurable.

c. Appurtenant Structures.

1. Spillway. The present condition of the spillway is poor. The spillway channel and wingwalls are extensively cracked and spalled. Low flows through the spillway pass between large cracks and through holes in the upper portion of the channel eventually emerging beneath the right wingwall (see Photograph 7) and discharging across the downstream toe. On the day of the inspection several inches of water flowed over the spillway crest; however, the discharge end of the spillway channel remained dry (see Photographs 5 and 6). The spillway channel is partially obstructed by small trees and silt deposits that occupy the approach area (see Photograph 5).

2. Outlet Conduit. The outlet conduit is reportedly functional and serves to supply water to the residents of Hawstone. The original gate tower along the upstream dam face is deteriorated and stripped of its inlet control mechanisms (see Photograph 8). Drawdown control was previously provided by a valve located at a "T" section about 80 feet downstream of the dam. The valve was removed in October 1979 and replaced with a standard elbow pipe section such that currently, no means of draining the reservoir is available.

d. Reservoir Area. The reservoir formed by Hawstone Dam is small covering less than 1/2-acre at maximum pool. The general surrounding area is characterized by steep rocky slopes that are heavily forested (see Photograph 1). No signs of slope distress were observed.

e. Downstream Channel. Hawstone Dam is situated in a steep and narrow valley approximately 800 feet from the Juniata River (see Figure 1). Pennsylvania Route 333 crosses the stream immediately below the dam as do three active tracks of the Penn Central Railroad. No permanent or temporary structures occupy the area between the dam and the Juniata River. Since the dam is unattended and somewhat isolated, failure could occur and remain undetected for a short period. Undetected damage to either the highway or the railroad tracks could endanger those unsuspecting persons who utilize these routes. Consequently, it is possible that appreciable economic loss and loss of life could result from a dam failure. Thus, the hazard classification of the facility is considered significant.

3.2 Evaluation.

The overall appearance of the facility suggests it to be in poor condition. Spalled and delaminated concrete surfaces along with a severely cracked and partially obstructed spillway indicate an overall lack of adequate maintenance. In addition, no means for draining the reservoir is presently available.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

Hawstone Dam is essentially a self-regulating facility. Excess inflows are automatically discharged through the uncontrolled spillway. The owner permits free use of the facility's water supply to the residents of nearby Hawstone by means of an 8-inch diameter cast iron supply pipe. No means of drawing down the reservoir is provided. No formal operating manual is available.

4.2 Maintenance of Dam.

Visual observations indicate that maintenance of the dam is presently minimal to non-existent. Needed repairs to the supply line system, when required, are performed by the residents of Hawstone who finance the work through a community collection. No formal maintenance manual is available.

4.3 Maintenance of Operating Facilities.

See Section 4.2 above.

4.4 Warning System.

No formal warning system is in effect.

4.5 Evaluation.

Maintenance of the dam and appurtenances appears to be minimal to non-existent. No means of draining the reservoir is presently available. There are no formal operations or maintenance manuals available for the facility nor is there a formal warning system in effect that could be used to notify appropriate highway and railroad personnel should emergency conditions develop at the dam.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No formal design reports or calculations are available. Correspondence contained in PennDER files indicates that the maximum design spillway capacity was reported to be 327 cfs based on a crest length of 18 feet and 3 feet of freeboard. This capacity was reported in 1918 to be "more than the expected runoff."

5.2 Experience Data.

Daily records of reservoir levels and/or spillway discharge are not available.

5.3 Visual Observations

The visual inspection revealed the spillway to be in poor condition. Extensive cracking and spalling of the concrete wingwalls and channel raise questions as to the overall integrity of the spillway structure under unusually heavy flows.

5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U.S. Army, Corps of Engineers, Hydrologic Engineering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the Spillway Design Flood (SDF) for Hawstone Dam ranges between the 100-year flood and the 1/2 PMF (Probable Maximum Flood). This classification is based on the relative size of the dam (small), and the potential hazard of

dam failure to downstream developments (significant). Due to the present potential for economic loss and possibly loss of life, the SDF for this facility is considered to be the 1/2 PMF.

b. Results of Analysis. Hawstone Dam was evaluated under near normal operating conditions. That is, the reservoir was initially at its normal pool or spillway elevation of 592 feet (MSL), with the spillway weir discharging freely. The outlet conduit was assumed to be non-functional. The spillway is a rectangular-shaped concrete chute channel with discharges controlled by a concrete broad-crested weir. All pertinent engineering calculations relative to the evaluation of this facility are provided in Appendix D.

Overtopping analysis (using the Modified HEC-1 Computer Program) indicated that the discharge/storage capacity of Hawstone Dam can accommodate only about 39 percent of the PMF prior to overtopping of the dam (Appendix D, Summary Input/ Output Sheets, Sheet C). The peak 1/2 PMF inflow of approximately 370 cfs was not attenuated by the discharge/ storage capabilities of the dam and reservoir, as the resulting peak 1/2 PMF outflow was also about 370 CFS (Summary Input/ Output Sheets, Sheet C). Under the 1/2 PMF, the dam would be overtopped for approximately 1.5 hours, with a maximum depth of inundation equal to about 0.3 feet (elevation 595.4 feet) above the low top of dam at elevation 595.1 feet (Summary Input/Output Sheets, Sheet C).

5.6 Spillway Adequacy.

Although Hawstone Dam cannot accommodate its SDF (1/2 PMF), the possible downstream consequences of dam failure due to overtopping were not evaluated. In accordance with Corps directive ETL-1110-2-234, breaching analysis of the dam was not performed, since the downstream reach was classified not as "high hazard," but as "significant hazard." Since Hawstone Dam cannot accommodate a 1/2 PMF-size flood, its spillway is considered to be inadequate, but not seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Dam. The visual inspection revealed the dam to be in poor condition, the apparent result of years of neglect and lack of adequate preventive maintenance. Continued deterioration could eventually lead to failure of the dam.

b. Appurtenant Structures.

1. Spillway. Visual observations indicate the spillway is in poor condition. Extensive cracking and concrete deterioration raise doubts as to the ability of the structure to withstand increased stresses concurrent with high flows. Water passing through cracks in the channel serves to undermine the soil foundation and could eventually lead to the collapse of the structure.

2. Outlet Conduit. The outlet conduit is reportedly functional in its capacity as a supply line; however, no means for draining the reservoir is presently available.

6.2 Design and Construction Techniques.

Little design information is available except for data relative to the design of the maximum dam section. It is noted that the designers analyzed the stability of the dam (sliding and overturning) by assuming no hydrostatic uplift pressure along its base. Such an assumption is contrary to modern accepted practice; however, local geologic conditions may indeed uphold its validity.

Stability relative to sliding and overturning was analyzed as part of this evaluation (see Appendix D-1, Sheets 1 through 6). Unacceptable safety factors (sliding = 0.7, overturning = 1.2) were obtained under full hydrostatic uplift; whereas, acceptable safety factors (sliding = 1.2, overturning = 2.4) resulted when uplift pressures were ignored as in the original design calculations. Only further investigation can accurately determine the existing condition relative to hydrostatic uplift. Nevertheless, the stability of the dam is undoubtedly greatly enhanced by the reported existence of foundation keys and by the fact that the downstream toe is buttressed by about 10 feet of soil and possibly rock. Based on the fact that the dam has been

in service for some 60 years and has probably experienced high flows approaching maximum pool level, the facility is believed to be stable. However, should the dam ever be overtopped or should the deteriorated spillway fail, it is likely that this toe support could be eroded leading to the failure of structure.

6.3 Past Performance.

PennDER records indicate that during the years under the ownership of the refractory, maintenance was performed regularly on the facility. The refractory closed in September 1968 (records are incomplete) and, subsequently, the dam was sold. A comparison of photographs of the facility dated 1961 indicate its condition to have progressively worsened due to an apparent lack of adequate maintenance.

6.4 Seismic Stability.

The dam is located within Seismic Zone No. 1 and may be subject to minor earthquake induced dynamic forces. The facility is presently considered to be stable and it is believed that, if static conditions continue to be satisfied, the dam can withstand the expected dynamic forces. However, no calculations or investigations were performed to confirm this opinion.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The results of this evaluation indicate the facility is in poor condition.

The size classification of the facility is small and its hazard classification is considered to be significant. In accordance with the recommended guidelines, the range of the Spillway Design Flood (SDF) for the facility is the 100-year flood to the 1/2 PMF (Probable Maximum Flood). Due to the potential for loss of life from sudden failure of the dam, the SDF is considered to be the 1/2 PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store about 39 percent of the PMF prior to dam overtopping. Thus, based on criteria contained in the recommended guidelines, the spillway is considered inadequate, but not seriously inadequate.

For the most part, deficiencies noted by the inspection team can be attributed to a lack of adequate maintenance which has allowed advanced stages of deterioration. Spalled and delaminated concrete surfaces along both faces of the dam and extensive cracking of the spillway structure are considered major causes for concern.

Although the structure is considered stable presently, it is difficult to assess the adequacy of its original design without further study. It is believed that if the dam were to be overtopped or if the deteriorated spillway would fail, toe support could be lost due to erosion possibly resulting in failure of the structure.

b. Adequacy of Information. The available data are considered sufficient to make a reasonable Phase I assessment of the facility.

c. Urgency. The following recommendations should be implemented immediately.

d. Necessity for Additional Investigations. Additional investigations to assess the structural and hydraulic adequacy of the spillway as well as leakage through the downstream dam face are considered necessary and are recommended below.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner immediately:

a. Develop a warning system to minimize the potential for loss of life and economic damage downstream of the facility in the event of a dam failure. The system should include provisions for around-the-clock surveillance during periods of unusually heavy precipitation and a communications plan with appropriate highway and railroad personnel.

b. Provide the present outlet conduit with a blowoff valve or develop an alternate means of draining the reservoir.

c. Have the spillway assessed by a registered professional engineer experienced in the design of concrete and hydraulic structures and take remedial measures required to adequately restore its function.

d. Have the deterioration and leakage observed on the downstream face of the dam assessed by a registered professional engineer experienced in the design of concrete structures and take remedial measures deemed necessary.

e. Have the spillway system evaluated by a registered professional engineer experienced in hydrology and hydraulics and take remedial measures necessary to make the spillway hydraulically adequate.

f. Develop formal manuals of maintenance and operations to ensure proper care of the facility.

APPENDIX A

VISUAL INSPECTION CHECKLIST AND FIELD SKETCHES

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Hawstone Dam STATE Pennsylvania COUNTY Mifflin

NDI # PA — 00580 PENNDER # 44-7

TYPE OF DAM Concrete-Gravity SIZE Small HAZARD CATEGORY Significant

DATE(S) INSPECTION 26 November 1979 WEATHER Rain TEMPERATURE 50° @ 1:00 pm

POOL ELEVATION AT TIME OF INSPECTION 592.3 feet M.S.L.

TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
B. M. Mihalcin	None Present	
D. J. Spaeder		
D. L. Bonk		

RECORDED BY D. L. Bonk

CONCRETE DAM

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00580
CONCRETE SURFACES	Crest in good condition. Upstream and downstream faces exhibit extensive concrete deterioration characterized by spalling, cracking, and delamination.
HORIZONTAL JOINTS	None observed due to extensive deterioration of the downstream face.
MONOLITHIC JOINTS	Joints separating individual concrete pours are visible across crest at 22, 51, 71 and 101 feet to the right of the spillway.
EFFLORESCENCE	Prevalent around cracks and joints along both the upstream and downstream faces.
JUNCTION OF DAM AND ABUTMENT	Good condition.

CONCRETE DAM

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00580
VERTICAL AND HORIZONTAL ALIGNMENT	Good condition.
ANY NOTICEABLE SEEPAGE	Slight leakage through vertical portion of downstream face to the left of the outlet conduit gate tower.
STAFF GAGE AND RECORDER	None observed.
DRAINS	None observed.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA · 00580
INTAKE STRUCTURE	Concrete gate tower along upstream embankment face in poor condition. Original slide gate control mechanisms have been removed, thus, flow is no longer controlled at the inlet. Tower is flooded and its interior presently inaccessible.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	8-inch diameter cast iron pipe (CIP).
OUTLET STRUCTURE	None.
OUTLET CHANNEL	Flow from blowoff was previously discharged into the wooded, V-shaped valley immediately below Hawstone Dam (see below).
GATE(S) AND OPERATIONAL EQUIPMENT	8-inch diameter gate valve formerly located on supply line approximately 80 feet downstream of dam was removed in the fall of 1979 and replace with a standard section of pipe. Presently dam cannot be drained without cutting the supply line.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00580
TYPE AND CONDITION	Uncontrolled, concrete, rectangular, chute channel spillway located at left abutment. Poor condition.
APPROACH CHANNEL	Small unlined approach area partially obstructed by debris and vegetation.
SPILLWAY CHANNEL AND SIDEWALLS	Concrete channel and sidewalls are extensively cracked and deteriorated. Small discharges over spillway weir pass through cracks in the channel floor adjacent the right wingwall. Water flows underneath the structure and eventually across the downstream embankment toe.
STILLING BASIN PLUNGE POOL	N/A
DISCHARGE CHANNEL	Spillway flow is discharged into the wooded V-shaped valley immediately below Hawstone Dam prior to entering the Juniata River.
BRIDGE AND PIERS EMERGENCY GATES	None.

SERVICE SPILLWAY

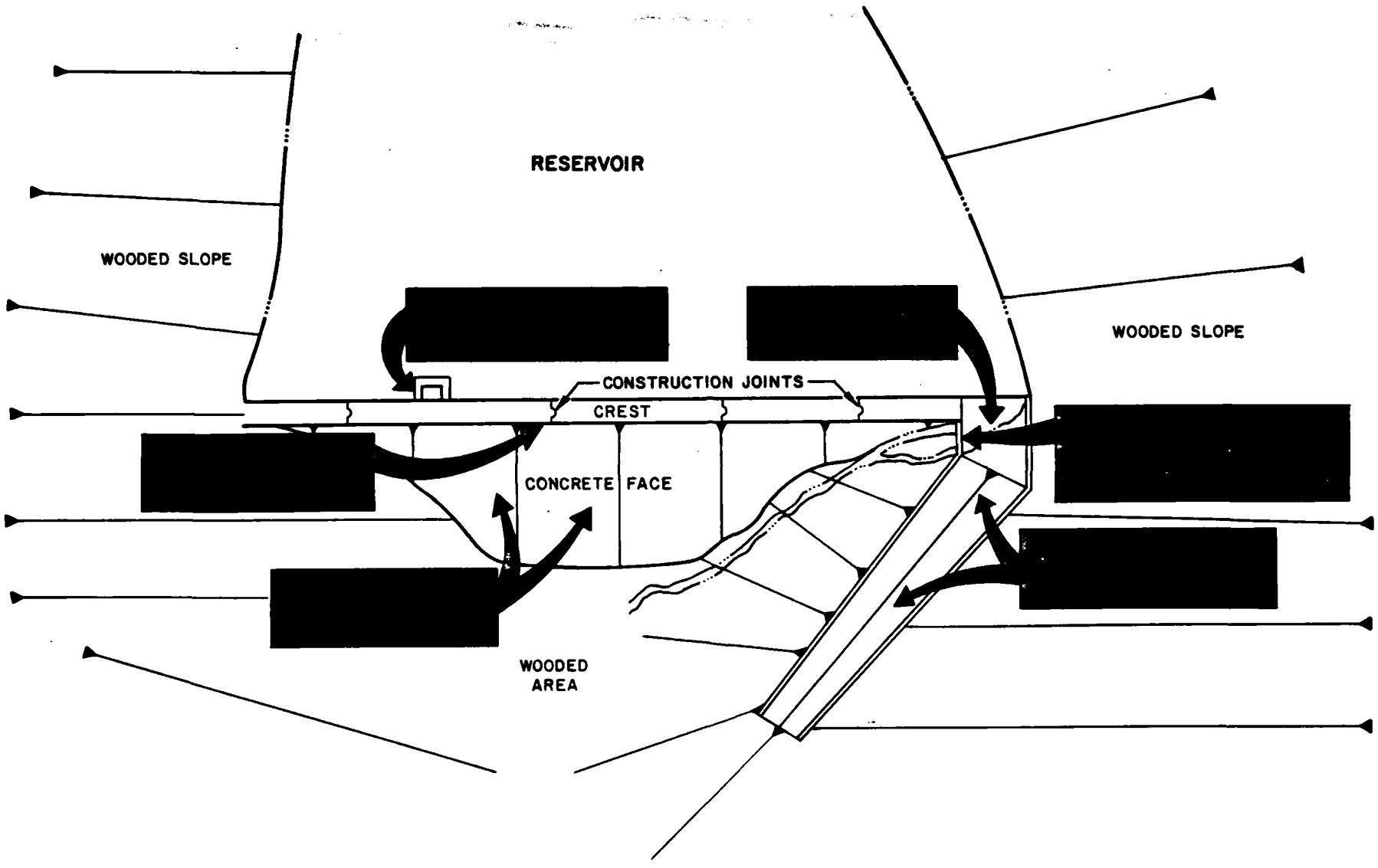
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00580
TYPE AND CONDITION	N/A
APPROACH CHANNEL	N/A
OUTLET STRUCTURE	N/A
DISCHARGE CHANNEL	N/A

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00580
MONUMENTATION SURVEYS	None observed.
OBSERVATION WELLS	None observed.
WEIRS	Small concrete, V-notch weir located several hundred feet upstream of dam along incoming stream.
PIEZOMETERS	None observed.
OTHERS	

RESERVOIR AREA AND DOWNSTREAM CHANNEL

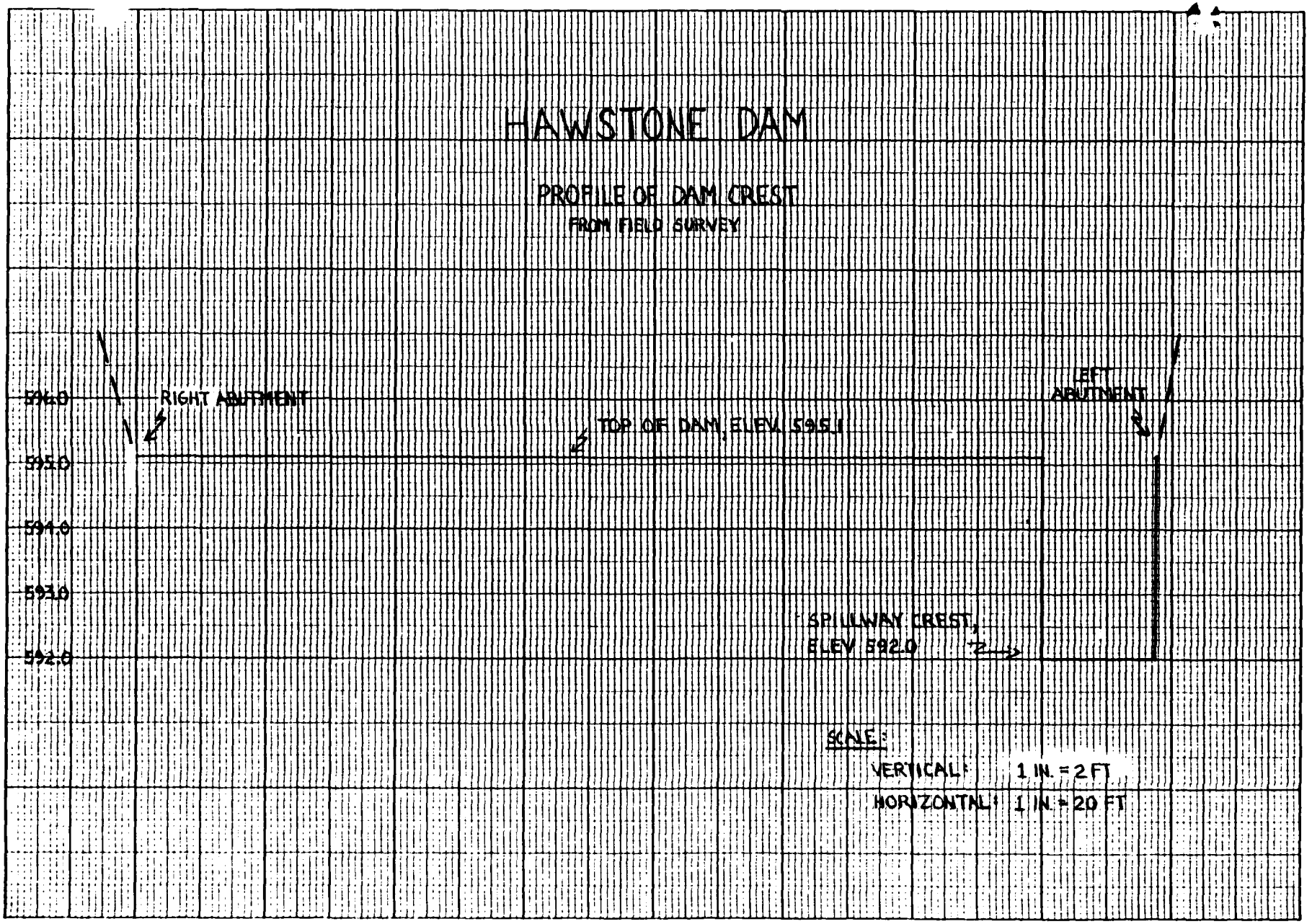
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA · 00580
SLOPES: RESERVOIR	The general surrounding area is characterized by steep rocky slopes that are heavily forrested. No signs of slope distress observed.
SEDIMENTATION	None observed.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	The dam is situated about 800 feet off the Juniata River. Normal stream flow passes through small culverts beneath PA Route 333 and three active tracks of the Penn Central railroad prior to reaching the Juniata River.
SLOPES: CHANNEL VALLEY	Steep, narrow, wooded valley.
APPROXIMATE NUMBER OF HOMES AND POPULATION	No permanent or temporary structures occupy the area between the dam and the Juniata River approximately 800 feet downstream. PA Route 333 crosses the stream immediately below the dam as do three active tracks of the Penn Central Railroad.



HAWSTONE DAM
GENERAL PLAN - FIELD INSPECTION NOTES

HAWSTONE DAM

PROFILE OF DAM CREST
FROM FIELD SURVEY



APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Hawstone Dam

ITEM	REMARKS NDI# PA - 00580
PERSONS INTERVIEWED AND TITLE	John Hostetter (owner: interviewed via telephone). Flloyd Ciccalini (unofficial spokesman for community of Hawstone, Pennsylvania: interviewed via telephone).
REGIONAL VICINITY MAP	See Figure 1, Appendix E.
CONSTRUCTION HISTORY	Designed and constructed by Berkebile Brothers of Johnstown, Pennsylvania for the Haws Refractories Company in 1920 (see Section 1.2.g).
AVAILABLE DRAWINGS	Drawings dated 1918 by Berkebile Brothers are contained in PennDER files (see Figures 2, 3, 4, and 5, Appendix E).
TYPICAL DAM SECTIONS	See Figures 2, 3, and 4, Appendix E.
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	 See Figure 2, Appendix E. See Figure 4, Appendix E. Not available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00580
SPILLWAY: PLAN SECTION DETAILS	See Figure 2, Appendix E. See Figure 3 and 4, Appendix E. None available.	
OPERATING EQUIP-MENT PLANS AND DETAILS	See Figure 4, Appendix E.	
DESIGN REPORTS	None available.	
GEOLOGY REPORTS	None available.	
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	Data utilized for the design of the maximum cross-section is contained in a brief report entitled "Data for Design of Hawstone Dam," by Berkebile Brothers (undated).	
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	See Figure 3, Appendix E.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00580
BORROW SOURCES	Not applicable.	
POST CONSTRUCTION DAM SURVEYS	None.	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Records of state inspections are contained in PennDER files. State permit application report dated August 21, 1918 discusses various design aspects in detail.	
HIGH POOL RECORDS	None available. Dam reportedly has never been overtopped.	
MONITORING SYSTEMS	None.	
MODIFICATIONS	Gate valve on supply line 80 feet downstream of dam was replaced in October 1979 with a standard pipe section, thereby eliminating the only available means of draining the reservoir.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00580
PRIOR ACCIDENTS OR FAILURES	None recorded.	
MAINTENANCE: RECORDS MANUAL	None.	
OPERATION: RECORDS MANUAL	None.	
OPERATIONAL PROCEDURES	Totally self-regulating.	
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None.	
MISCELLANEOUS		

GAI CONSULTANTS, INC.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # 00580
PENNDER ID # 44-7

SIZE OF DRAINAGE AREA: 0.22 square miles.

ELEVATION TOP NORMAL POOL: 592 STORAGE CAPACITY: 5.2 acre-feet

ELEVATION TOP FLOOD CONTROL POOL: - STORAGE CAPACITY: -

ELEVATION MAXIMUM DESIGN POOL: - STORAGE CAPACITY: -

ELEVATION TOP DAM: 595.1 STORAGE CAPACITY: 6.5 acre-feet

SPILLWAY DATA

CREST ELEVATION: 592 feet.

TYPE: Uncontrolled, concrete, rectangular chute channel.

CREST LENGTH: 17.4 feet.

CHANNEL LENGTH: 74 feet.

SPILLOVER LOCATION: Left abutment.

NUMBER AND TYPE OF GATES: None.

OUTLET WORKS

TYPE: 8-inch diameter CIP supply line.

LOCATION: Near right abutment.

ENTRANCE INVERTS: 565 feet.

EXIT INVERTS: Not available.

EMERGENCY DRAWDOWN FACILITIES: None.

HYDROMETEOROLOGICAL GAGES

TYPE: None.

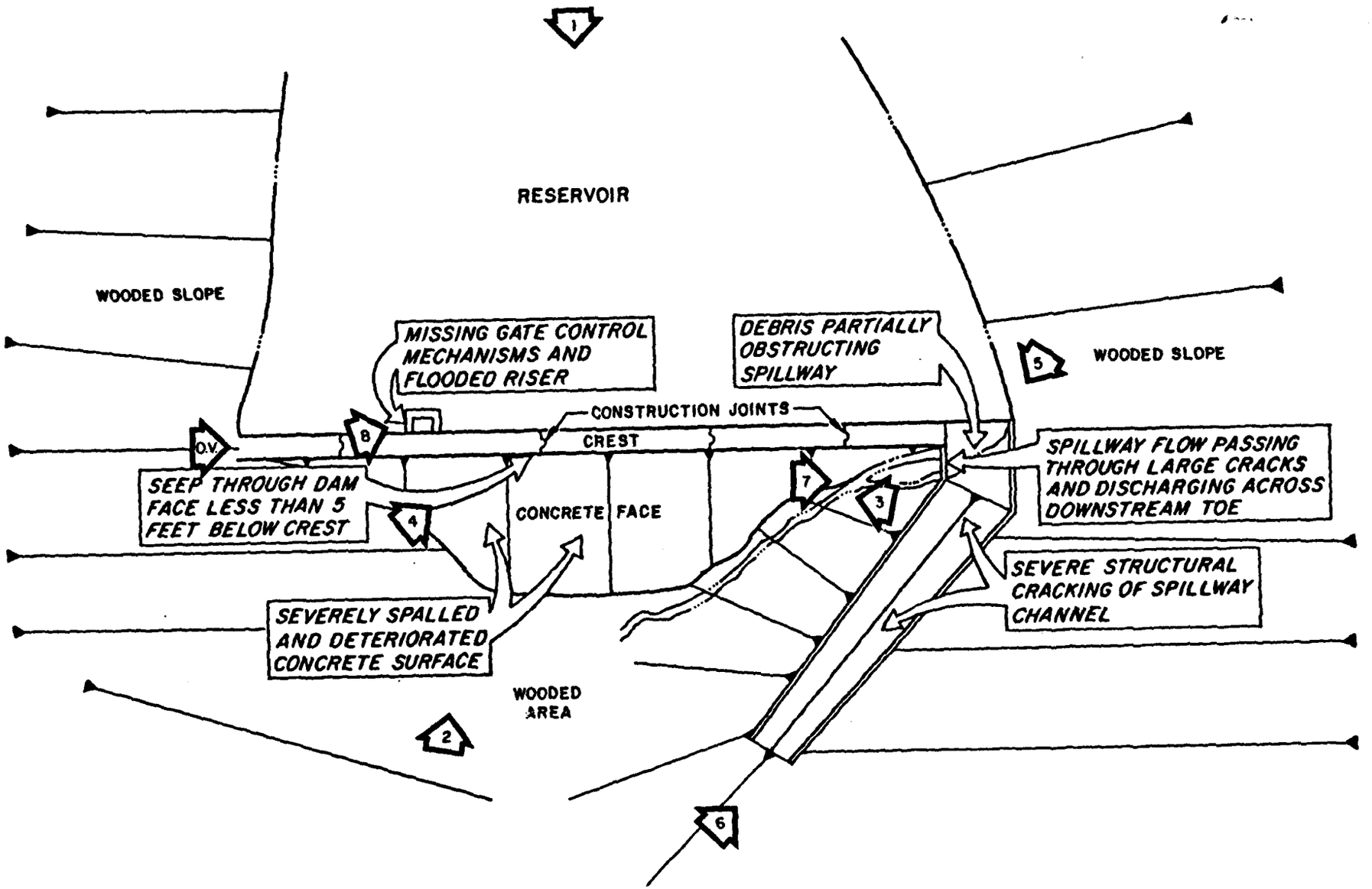
LOCATION: -

RECORDS: -

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

APPENDIX C

PHOTOGRAPHS



HAWSTONE DAM
PHOTOGRAPH KEY MAP

PHOTOGRAPH 1 View of the reservoir and upstream face of Hawstone Dam.

PHOTOGRAPH 2 View of the downstream face of Hawstone Dam.

PHOTOGRAPH 3 Close-up view of the deteriorated concrete condition along the downstream dam face as seen from the spillway wingwall.

PHOTOGRAPH 4 Close-up view of an area of leakage (black area in upper center portion of view) through the downstream dam face.

1

2

3

4

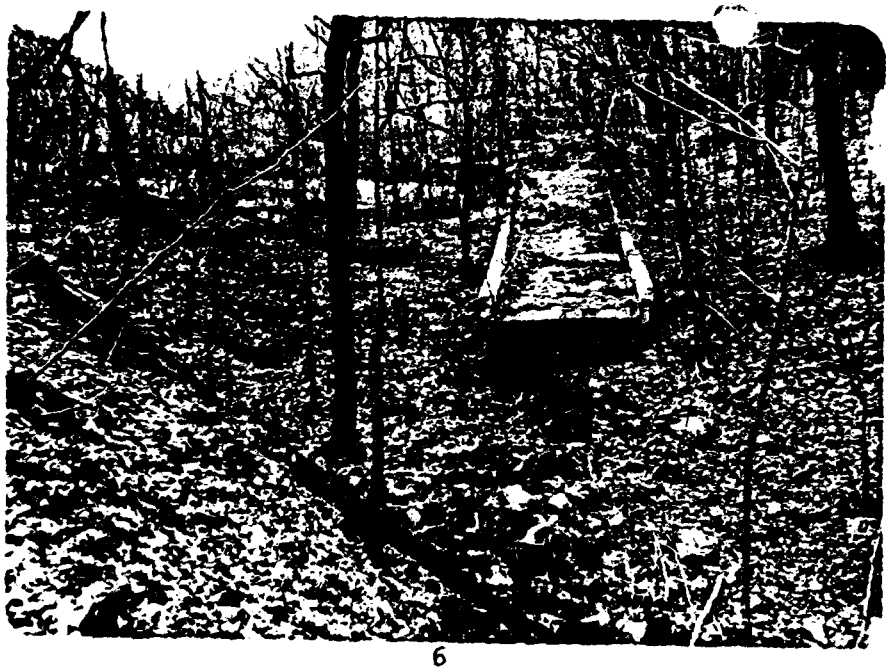
PHOTOGRAPH 5 View, looking downstream, of the entrance to the spillway as seen from the left abutment hillside.

PHOTOGRAPH 6 View, looking upstream, of the spillway discharge channel.

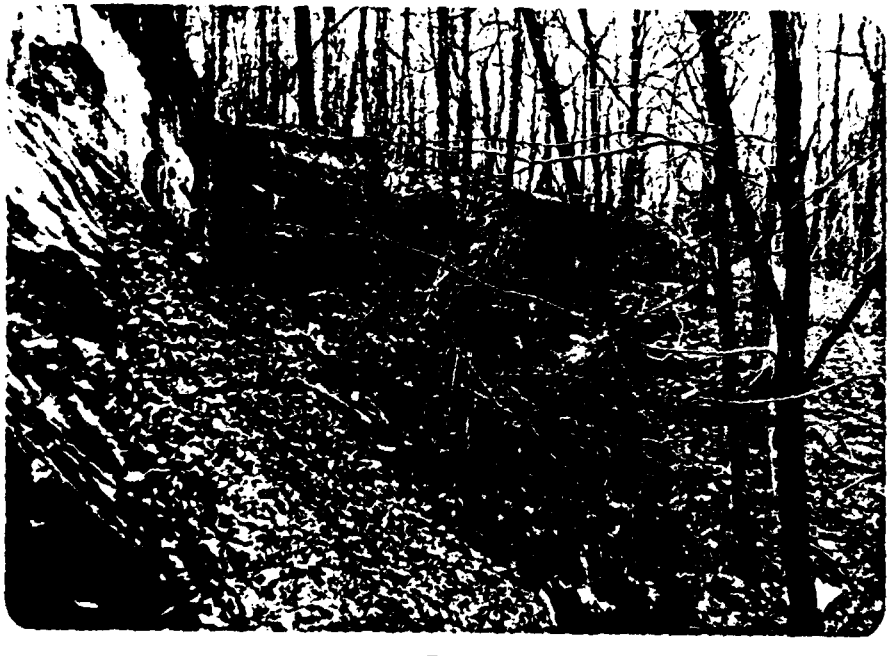
PHOTOGRAPH 7 View of spillway flow discharging beneath the spillway right wingwall.

PHOTOGRAPH 8 View of the deteriorated and dismantled gate tower that abuts the upstream dam face near the right abutment.

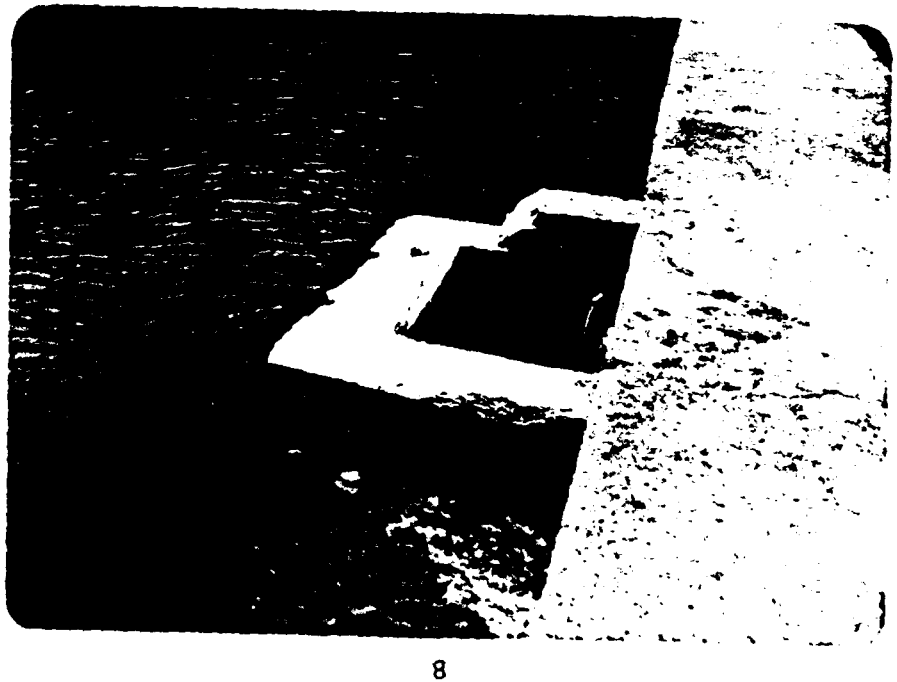
5



6



7



8

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s), time(s) of the peak discharge(s), and the maximum stage(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevations of failure hydrographs for each location.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: HAWSTONE DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.2 INCHES/24 HOURS (1)

STATION	1	2	3
STATION DESCRIPTION	HAWSTONE DAM		
DRAINAGE AREA (SQUARE MILES)	0.22		
CUMULATIVE DRAINAGE AREA (SQUARE MILES)			
ADJUSTMENT OF PMF FOR DRAINAGE AREA LOCATION (%) (1)			
6 HOURS	121		
12 HOURS	131		
24 HOURS	140		
48 HOURS	147		
72 HOURS	149		
SNYDER HYDROGRAPH PARAMETERS			
ZONE (2)	21		
C_p (3)	0.55		
C_t (3)	1.50		
L (MILES) (4)	0.9		
L_{ca} (MILES) (4)	0.4		
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (HOURS)	1.10		
SPILLWAY DATA			
CREST LENGTH (FEET)	17.4		
FREEBOARD (FEET)	3.1		

(1) HYDROMETEOROLOGICAL REPORT 40, U.S. WEATHER BUREAU, 1965.

(2) HYDROLOGIC ZONE DEFINED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT, FOR DETERMINATION OF SNYDER COEFFICIENTS (C_p AND C_t).

(3) SNYDER COEFFICIENTS

(4) L = LENGTH OF LONGEST WATERCOURSE FROM DAM TO BASIN DIVIDE.
L_{ca} = LENGTH OF LONGEST WATERCOURSE FROM DAM TO POINT OPPOSITE BASIN CENTROID.

JECT DAM SAFETY INSPECTION

HOWSTONE DAM

BY JTS DATE 1-2-80 PROJ. NO. 79-207-530

CHKD. BY DLB DATE 1-8-80 SHEET NO. 1 OF 11

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DAM STATISTICS

- HEIGHT OF DAM ≈ 34 FT (FIELD MEASUREMENT)

- NORMAL POOL STORAGE CAPACITY ≈ 1.685 x10⁶ GALLONS
  ≈ 5.17 ACRE-FT (NOTE 1)
  ≈ 5.2 ACRE-FT

- MAXIMUM POOL STORAGE CAPACITY ≈ 5.7 ACRE-FT ≈ 5.5 ACRE-FT (SHEET 5)
  (@ LOW TOP OF DAM)

- DRAINAGE AREA ≈ 0.22 SQUARE MILES (PLANIMETERED ON USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE)

- ELEVATION OF TOP OF DAM (FIELD) ≈ 515.1

- NORMAL POOL ELEVATION ≈ 592.0 (FIGURE 3, SEE SHEET 6)

- UPSTREAM INLET INVERT ELEVATION ≈ 565.0 (FIGURE 4, SEE SHEET 7)

- DOWNSTREAM OUTLET INVERT - NOT KNOWN

- STREAMBED @ DAM CENTERLINE 560.0 (FIGURE 2, SEE NOTE 2)

NOTE 1: OBTAINED FROM "REPORT UPON THE APPLICATION OF HAWS REFRACTORIES CO., HOWSTONE DAM, HOWSTONE, OHIO" ON FILE IN TOWNSHIP FILES.

JECT Dam Safety Inspection
Hawstone Dam

BY DJS DATE 1-7-80 PROJ. NO. 79-303-550

CHKD. BY DLG DATE 1-8-80 SHEET NO. 2 OF 11

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

NOTE 2: DESIGN DRAWINGS ARE BASED ON A NORMAL POOL ELEVATION OF 212.0 FEET. HOWEVER, THE USGS TOPO QUAD FOR LEWISTOWN, PA, INDICATES THAT NORMAL POOL ELEVATION IS SOMEWHERE BETWEEN 580.0 AND 600.0. THE RESERVOIR AREA AT ELEVATION 2222 AS PLANIMETERED ON FIGURE 5, IS APPROXIMATELY 0.53 ACRES, WHICH IS ALSO THE VALUE OBTAINED AT ELEVATION 600.0 ON THE USGS TOPO MAP. THUS, IT WILL BE ASSUMED THAT ELEVATION 380.0 ON THE DESIGN DRAWINGS CORRESPONDS TO ELEVATION 600.0 ON THE U.S.G.S. TOPO. THEREFORE, A VALUE OF 380.0 HAS BEEN ADDED TO ALL THE RELATED ELEVATIONS ON THE DESIGN DRAWINGS. FOR INSTANCE, NORMAL POOL ELEVATION, RELATED AS 212.0 FEET, WILL BE ASSUMED TO BE 212.0 + 380.0, OR 592.0. (NOTE: THE ELEVATIONS USED IN THIS ANALYSIS ARE CONSIDERED ESTIMATES AND ARE NOT NECESSARILY ACCURATE).

DAM CLASSIFICATION

DAM SIZE: SMALL (REF 1, TABLE 1)

HAZARD CLASSIFICATION: SIGNIFICANT (FIELD OBSERVATION)

REQUIRED SDF: 100-YEAR TO ½ PMF (REF 1, TABLE 3)

HYDROGRAPH PARAMETERS

- LENGTH OF LONGEST WATERCOURSE: L = 0.9 MILES (MEASURED ON USGS TOPO QUAD: LEWISTOWN)

- LENGTH OF LONGEST WATERCOURSE FROM DAM TO A POINT OPPOSITE BASIN CENTROID: L_{CA} = 0.4 MILES

PROJECT: Dam Safety Inspection

Hawstone Dam

BY: DJS DATE: 1-3-80 PROJ. NO. 79-[illegible]-520

CHKD. BY: DLB DATE: 1-8-80 SHEET NO. 3 OF 11

GAI CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Specialists

C_t = 1.50

C_p = 0.55

(Supplied by COE, Zone 21, Susquehanna River Basin)

Snyder's Standard Lag: $t_p = C_t (L \cdot L_{ca})^{0.3}$

$= (1.50)(0.9 \times 0.4)^{0.3}$

$= 1.10$ Hours

(Note: Hydrograph variables used here are defined in Reference 3, in section entitled "Snyder Synthetic Unit Hydrograph.")

Reservoir Capacity Table

Reservoir Surface Areas:

Reservoir Elevation (ft)	Surface Area* (acres)
561.0	0
565.0	0.04
570.0	0.09
575.0	0.12
580.0	0.19
585.0	0.25
590.0	0.33
[illegible]	0.37
595.0	0.42
[illegible]	0.53
601.0	1.05

* [illegible] planimetered [illegible]

IECT Dam Safety Investigation
Mainstone Dam

BY DJS DATE 1-3-80 PROJ. NO. [illegible]

CHKD. BY DLB DATE 1-8-80 SHEET NO. 4 OF 11

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

IT IS ASSUMED THAT THE MODIFIED PRISMOIDAL RELATIONSHIP ADEQUATELY MODELS THE RESERVOIR SURFACE AREA + STORAGE RELATIONSHIP. SINCE THE CAPACITY AT NORMAL POOL IS KNOWN, THE CALCULATED VOLUMES CAN BE ADJUSTED ACCORDINGLY.

$$\Delta V_{1-2} = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 \cdot A_2}\right) \qquad \text{(SEE TP-15)}$$

WHERE ΔV_{1-2} = INCREMENTAL VOLUME BETWEEN ELEVATIONS 1 & 2, IN FEET,
h = ELEVATION 1 − ELEVATION 2, IN FEET,
A_1 = SURFACE AREA AT ELEVATION 1, IN ACRES,
A_2 = SURFACE AREA AT ELEVATION 2, IN ACRES.

ALSO, ASSUME THAT THE SURFACE AREA VARIES LINEARLY BETWEEN ELEVATIONS 600.0 AND 620.3.

$$A_i = A_{600} + \left(\frac{\Delta SA}{\Delta H} \times H\right) \quad \text{ACRES}$$

$$= 0.53 + \left(\frac{1.03 - 0.53}{620.0 - 600.0} \times H\right)$$

$$= 0.53 + (0.0245 \times H)$$

WHERE H = ELEV i − 600.0 FT

IT IS ALSO ASSUMED THAT SURFACE AREA VARIES LINEARLY BETWEEN ELEVATIONS 592.0 AND 595.0, AND BETWEEN 595.0 AND 600.0.

BETWEEN 592.0 AND 595.0 : $A_i = A_{592} + \left(\frac{2.42 - 2.07}{595 - 592} \times H\right)$
$= 2.07 + (0.0167 \times H)$

BETWEEN 595.0 AND 600.0 : $A_i = A_{595} + \left(\frac{0.53 - 2.42}{600 - 595} \times H\right)$
$= 0.42 + (0.378 \times H)$

IECT DAM SAFETY INSPECTION
HAWSTONE DAM

BY DJS DATE 1-3-80 PROJ. NO. 79-307-553

CHKD. BY DLB DATE 1-8-80 SHEET NO. 5 OF 11

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

ELEVATION - STORAGE TABLE :

	RESERVOIR ELEVATION (FT)	A_i (ACRES)	ΔV_{1-2} (AC-FT)	INITIAL CALCULATED TOTAL VOLUME (AC-FT)	FINAL CALCULATED VOLUME * (AC-FT)
	561.0 **	0	—	0	0
	565.0	0.04	0.05	0.05	0.05
	570.0	0.08	0.29	0.34	0.36
	575.0	0.13	0.50	0.84	0.89
	580.0	0.19	0.77	1.61	1.71
	585.0	0.25	1.10	2.71	2.88
	590.0	0.33	1.45	4.16	4.43
(NORMAL POOL)	592.0	0.37	0.70	4.86	5.17
	593.0	0.39	0.38	5.24	5.58
	594.0	0.40	0.39	5.63	5.99
	595.0	0.42	0.41	6.04	6.43
(TOP OF DAM)	595.1	0.42	0.04	6.08	6.47
	596.0	0.44	0.39	6.47	6.88
	598.0	0.49	0.93	7.40	7.87
	600.0	0.53	1.02	8.42	8.96
	602.0	0.58	1.11	9.53	10.14
	605.0	0.65	1.84	11.37	12.10

* FINAL CALCULATED VOLUME = (INITIAL CALCULATED VOLUME) X (CORRECTION FACTOR),

WHERE CORRECTION FACTOR = $\left(\frac{\text{KNOWN VOLUME AT NORMAL POOL}}{\text{INITIAL CALCULATED VOL AT NORMAL POOL}}\right)$

$= \frac{5.7}{5.36} = 1.064$

** FROM FIGURE 5.

JECT Dam Safety Inspection

Jewistone Dam

BY JTS DATE 1-4-80 PROJ. NO. 79-027-593

CHKD. BY DLB DATE 1-8-80 SHEET NO. 6 OF 11

gai CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Specialists

PMP CALCULATIONS

- From Reference 7, Figure 9, obtain PMP value for a basin of drainage area 200 square miles, and for a duration of 24 hours:

PRECIP = 22.2 inches

- From Ref 7, Fig 1, the seasonal adjustment factor = 103%

- Area Correction Factor (Ref 9):

DURATION (HRS):	6	12	24	48	72
FACTOR (%):	117.5	127.0	136.3	142.5	145.0

- Total Correction Factor (1.03 x AREA CORRECTION FACTOR):

DURATION (HRS):	6	12	24	48	72
FACTOR (%):	121	131	140	147	149

- Hod Brook Factor (adjustment for basin shape and for the lesser likelihood of a severe storm centering over a small basin) for a drainage area of 1.22 square miles is 1.30

(Ref 4, p. 7-1)

JECT DAM SAFETY INSPECTION

HAWSTONE DAM

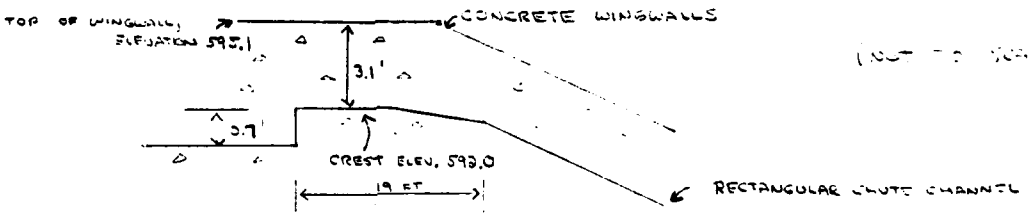
BY DJS DATE 1-4-80 PROJ. NO. 79-303-500

CHKD. BY DLB DATE 1-8-80 SHEET NO. 7 OF 11

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SPILLWAY CAPACITY

PROFILE OF SPILLWAY:



(NOT TO SCALE)

(FROM FIELD NOTES, DESIGN DRAWINGS)

THE SPILLWAY IS A RECTANGULAR CONCRETE CHUTE CHANNEL WITH DISCHARGE CONTROLLED BY A BROAD-CRESTED WEIR. DISCHARGE OVER THE WEIR CAN BE ESTIMATED BY THE RELATION

$$Q = CLH^{3/2}$$ (REF 5, p. 5-23)

WHERE Q = DISCHARGE, IN CFS,
C = DISCHARGE COEFFICIENT,
L = LENGTH OF SPILLWAY CREST = 17.4 FT,
H = TOTAL HEAD ON CREST, IN FEET.

A DISCHARGE COEFFICIENT OF 3.1 WILL BE USED, BASED ON THE GEOMETRY OF THE WEIR. (IT IS ASSUMED THAT CRITICAL DEPTH OCCURS AT THE DOWNSTREAM END OF THE WEIR, OR AT THE BREAK IN SLOPE OF THE SPILLWAY CHANNEL.)

(REF 5, p. 5-23)

JECT DAM SAFETY INSPECTION
HAWSTONE DAM

BY JJS DATE 1-4-80 PROJ. NO. 79-207-EXJ

CHKD. BY DLB DATE 1-8-80 SHEET NO. 8 OF 11

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

APPROACH FLOWS AND DOWNSTREAM EFFECTS ARE ASSUMED TO BE NEGLIGIBLE HERE.

SPILLWAY RATING TABLE

RESERVOIR ELEVATION (FT)	H (FT)	Q* (CFS)	RESERVOIR ELEVATION (FT)	H (FT)	Q (CFS)
592.0	0	0	599.0	7.0	990
593.0	1.0	50	600.0	8.0	1220
594.0	2.0	150	601.0	9.0	1450
595.0	3.0	280	603.0	11.0	1700
(TOP OF DAM) 595.1	3.1	290	603.0	11.0	1960
596.0	4.0	430	604.0	12.0	2230
597.0	5.0	600	605.0	13.0	2520
599.0	7.0	990			

* $Q = CLH^{3/2} = (3.347)(17.4)\,H^{3/2}$
$= 53.71\,H^{3/2}$

IECT Dam Safety Inspection

HAWKSTONE DAM

BY JJS DATE 1-4-80 PROJ. NO. 79-227-5[illegible]

CHKD. BY JGB DATE 1-8-80 SHEET NO. 9 OF 11

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

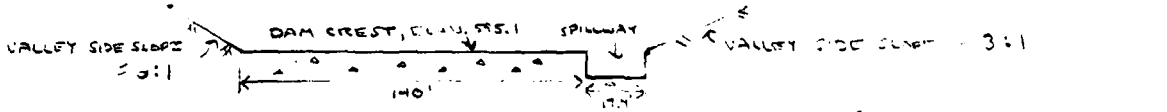
DAM CREST RATING CURVE

ASSUME THAT THE CREST OF THE DAM BEHAVES ESSENTIALLY AS A BROAD-CRESTED WEIR WHEN OVERTOPPED. THUS, THE DISCHARGE CAN BE ESTIMATED BY THE EQUATION

$$Q = CLH^{3/2} \qquad \text{(REF 5, p 5-23)}$$

WITH Q, C, L, H AS DEFINED ON SHEET 7.

THE LENGTH OF THE CREST IS 140 FEET, AND THE BREADTH IS 6 FEET. THE AVERAGE VALLEY SIDE SLOPE ADJACENT TO THE DAM IS APPROXIMATELY 2.5 : 1.



(NOT TO SCALE)

(FROM FIELD NOTES AND USGS TOPO MAP)

— SECTION LOOKING UPSTREAM —

IT WILL BE ASSUMED THAT THE VELOCITY OF THE FLOW OVER THE SIDE-SLOPES IS EQUAL TO THE VELOCITY OVER THE DAM CREST, SO

$$V_s = V_c = \frac{Q_c}{A_c} = \frac{Q_c}{H L_c}$$

WHERE V_s = VELOCITY OF FLOW OVER SIDE SLOPE (FT/SEC),
V_c = VELOCITY OF FLOW OVER CREST SECTION (FT/SEC),
Q_c = DISCHARGE OVER DAM CREST (CFS),
L_c = LENGTH OF CREST = 140 FT,
H = HEAD (FT).

PROJECT DAM SAFETY INSPECTION
HAINSTONE DAM

BY DJS DATE 1-4-80 PROJ. NO. 79-207-550
CHKD. BY DLB DATE 1-8-80 SHEET NO. 10 OF 11

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

AND $Q_s = V_s A_s$,

WHERE Q_s = DISCHARGE OVER THE SIDE SLOPES (CFS),
A_s = AREA OF FLOW OVER SIDE SLOPES (FT^2)
$= (2)(\frac{1}{2})(H)(2.5H)$
$= 2.5H^2$

$\therefore Q_{TC} = Q_c + Q_s$, WHERE Q_{TC} = TOTAL DISCHARGE OVER CREST (CFS).

RATING TABLE FOR CREST OF DAM:

RESERVOIR ELEVATION (FT)	H (FT)	① C	② Q_c (CFS)	③ A_c (FT^2)	④ $V_c = V_s$ (FPS)	⑤ A_s (FT^2)	⑥ Q_s (CFS)	⑦ Q_{T-C} (CFS)
595.1	0	—						
595.3	0.2	2.4	30	28	1.1	0	0	30
595.5	0.4	2.5	90	56	1.6	0	0	90
596.0	0.9	2.7	320	126	2.5	2	10	330
597.0	1.9	2.7	990	266	3.7	9	30	1020
598.0	2.9	2.7	1870	406	4.6	31	100	1970
599.0	3.9	2.7	2910	546	5.3	58	200	3110
600.0	4.9	2.7	4250	686	6.2	80	370	4620
601.0	5.9	2.9	5820	826	7.0	97	610	6430
602.0	6.9	3.0	7610	966	7.9	119	940	8550

① ESTIMATED FROM REF. 5, TABLE 5-3.
② $Q_c = CLH^{3/2} = 140\,CH^{3/2}$
③ $A_c = HL_c = 140\,H$
④ $V_c = Q_c / A_c$
⑤ $A_s = 2.5H^2$
⑥ $Q_s = A_s V_s$
⑦ $Q_{TC} = Q_c + Q_s$

PROJECT DAM SAFETY INSPECTIONS
HAWSTONE DAM

BY DJS DATE 1-4-80 PROJ. NO. [illegible]-592

CHKD. BY DLB DATE 1-8-80 SHEET NO. 11 OF 11

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

TOTAL FACILITY RATING TABLE

$Q_{TOTAL} = Q_{SPILLWAY} + Q_{DAM\ CREST}$

	RESERVOIR ELEVATION (FT)	$Q_{SPILLWAY}$ (CFS)	$Q_{DAM\ CREST}$ (CFS)	Q_{TOTAL} (CFS)
	592.0	0	—	0
	593.0	50	—	50
	594.0	150	—	150
	595.0	280	—	280
(TOP OF DAM)	595.1	290	0	290
	595.3	320 *	30	350
	595.5	350 *	90	440
	596.0	430	330	760
	597.0	600	1020	1620
	598.0	790	1970	2760
	599.0	990	3110	4100
	600.0	1320	4620	5940
	601.0	1450	6430	7880
	602.0	1700	8550	10,250

* - BY LINEAR INTERPOLATION.

SUMMARY INPUT/OUTPUT SHEETS

DAM SAFETY INSPECTION
HAWSTONE DAM ****** OVERTOPPING ANALYSIS ******
15-MINUTE TIME STEP AND 72-HOUR STORM DURATION

JOB SPECIFICATION

NB	NMIN	METRIC	IHR	IMIN	IPLT	IPRT	NSTAN
ZERO	0	15	0	0	0	0	0

JOPER	NWT	LRUPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1

RATIOS .20 .30 .40 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RESERVOIR INFLOW

ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0

JPLT	JPRT	IAREA	JSMAP	TAREA	SNAP	RATIO	ISAME	LOCAL
1	1	.22	0.00	.22	0.00	0.000	0	0

PRECIP DATA

SCS	PMS	R6	R12	R24	R48	R72	R96
0.00	22.20	121.00	141.00	140.00	137.00	139.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .900

INITIAL AND CONSTANT RAINFALL LOSSES AS PER COE

LOSS DATA

LROPT	STRTL	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMS	RTIMP
0	0.00	.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

BASE FLOW PARAMETERS AS PER COE

TP= 1.10 CP= .55 NEA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 4.90 AND R= 5.17 INTERVALS

UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES, LAG= 1.09 HOURS, CP= .55 VOL= 1.00

7.	24.	46.	64.	70.	63.	52.	43.	35.	29.
24.	20.	16.	13.	11.	9.	7.	6.	5.	4.
3.	3.	2.	2.	2.	1.	1.	1.	1.	1.

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.46	23.85	2.61	13751.
										(677.11	608.11	66.11	389.18)

OVERTOPPING

PROJECT DAM SAFETY INSPECTION
HAWSTONE DAM
BY RTI DATE 1-22-80 PROJ. NO. 79-293-580
CHKD. BY DLB DATE 1-17-80 SHEET NO. A OF C

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DAM SAFETY INSPECTION

HAWSTONE DAM

BY JTS DATE 1-17-80 PROJ. NO. 79-203-580

CHKD. BY PLB DATE 1-17-80 SHEET NO. B OF C

UMA CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Specialists

INFLOWS INTO RESERVOIR

0.3 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	225.	133.	42.	14.	4127.
CMS	6.	4.	1.	0.	117.
INCHES		5.63	7.10	7.27	7.27
MM		144.06	180.45	184.69	184.69
AC-FT		66.	83.	85.	85.
THOUS CU M		81.	103.	105.	105.

0.4 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	300.	178.	56.	19.	5503.
CMS	9.	5.	2.	1.	156.
INCHES		7.51	9.47	9.69	9.69
MM		190.74	240.47	246.25	246.25
AC-FT		88.	111.	114.	114.
THOUS CU M		109.	137.	140.	140.

0.5 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	376.	222.	70.	24.	6879.
CMS	11.	6.	2.	1.	195.
INCHES		9.39	11.83	12.12	12.12
MM		238.43	300.59	307.82	307.82
AC-FT		110.	139.	142.	142.
THOUS CU M		136.	171.	175.	175.

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
101	1	0	0	0	0	1	0	0

ROUTING DATA

RLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	ITSK	X	TSK	STORA	ISPRAT
1	0	0.000	0.000	0.000	5.	-1

STAGE	592.00	593.00	594.00	595.00	595.10	595.30	595.50	596.00	597.00	598.0
	591.00	600.00	601.00	602.00						
FLOW	0.	50.	150.	280.	290.	350.	440.	760.	1620.	2760.
	4100.00	5840.	7860.	10250.						
CAPACITY	0.	0.	0.	1.	2.	3.	4.	5.	6.	6.
	6.	7.	7.	8.	9.	10.	12.			
ELEVATION	561.	565.	570.	575.	580.	585.	590.	592.	593.	594.
	595.	595.	596.	598.	600.	602.	605.			

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
592.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
595.1	0.0	0.0	0.

JECT DAM SAFETY INSPECTION

HAWSTONE DAM

BY DJS DATE 6-12-80 PROJ. NO. 79-203-580

CHKD. BY DLB DATE 1-17-80 SHEET NO. C OF C

GEI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

RESERVOIR OUTFLOW HYDROGRAPHS

OVERTOPPING OCCURS AT ≈ 0.39 PMF

PEAK OUTFLOW IS 225. AT TIME 40.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME	
CFS	225.	133.	42.	14.	4171.	0.3 PMF
CMS	6.	4.	1.	0.	117.	
INCHES		5.63	7.10	7.27	7.27	
MM		143.00	180.35	184.69	184.69	
AC-FT		66.	83.	85.	85.	
THOUS CU M		81.	103.	105.	105.	

PEAK OUTFLOW IS 299. AT TIME 40.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME	
CFS	299.	178.	56.	19.	5303.	0.4 PMF
CMS	8.	5.	2.	1.	156.	
INCHES		7.51	9.47	9.70	9.70	
MM		190.67	240.47	246.25	246.25	
AC-FT		88.	111.	114.	114.	
THOUS CU M		109.	137.	140.	140.	

PEAK OUTFLOW IS 371. AT TIME 40.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME	
CFS	371.	222.	70.	24.	6879.	0.5 PMF
CMS	10.	6.	2.	1.	195.	
INCHES		9.39	11.83	12.12	12.12	
MM		238.36	300.60	307.83	307.83	
AC-FT		110.	139.	142.	142.	
THOUS CU M		136.	171.	175.	175.	

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	592.00	592.00	595.10
STORAGE	5.	5.	7.
OUTFLOW	0.	0.	290.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	594.00	0.00	6.	150.	0.00	40.75	0.00
.30	594.58	0.00	6.	225.	0.00	40.75	0.00
.39*	595.10	—	7	290.	—	—	—
.40	595.13	.03	7.	299.	.50	40.75	0.00
.50	595.35	.25	7.	371.	1.50	40.75	0.00
1.00	595.99	.89	7.	751.	4.50	40.75	0.00

LIST OF REFERENCES

1. "Recommended Guidelines for Safety Inspection of Dams," prepared by Department of the Army, Office of the Chief of Engineers, Washington, D. C. (Appendix D).

2. "Unit Hydrograph Concepts and Calculations," by Corps of Engineers, Baltimore District (L-519).

3. "Seasonal Variation of Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Duration of 6, 12, 24, and 48 Hours," Hydrometeorological Report No. 33, prepared by J. T. Riedel, J. F. Appleby and R. W. Schloemer, Hydrologic Service Division Hydrometeorological Section, U. S. Department of the Army, Corps of Engineers, Washington, D. C., April 1956.

4. Design of Small Dams, U. S. Department of the Interior, Bureau of Reclamation, Washington, D. C., 1973.

5. Handbook of Hydraulic, H. W. King and E. F. Brater, McGraw-Hill, Inc., New York, 1963.

6. Standard Handbook for Civil Engineers, F. S. Merritt, McGraw-Hill, Inc., New York, 1968.

7. Open-Channel Hydraulics, V. T. Chow, McGraw-Hill, Inc., New York, 1959.

8. Weir Experiments, Coefficients, and Formulas, R. E. Horton, Water Supply and Irrigation Paper No. 200, Department of the Interior, United States Geological Survey, Washington, D. C., 1907.

9. "Probable Maximum Precipitation Susquehanna River Drainage Above Harrisburg, Pennsylvania," Hydrometeorological Report 40, prepared by H. V. Goodyear and J. T. Riedel, Hydrometeorological Branch Office of Hydrology, U. S. Weather Bureau, U. S. Department of Commerce, Washington, D. C., May 1965.

10. Flood Hydrograph Package (HEC-1) Dam Safety Version, Hydrologic Engineering Center, U. S. Army, Corps of Engineers, Davis, California, July 1978.

11. "Simulation of Flow Through Broad Crest Navigation Dams with Radial Gates," R. W. Schmitt, U. S. Army, Corps of Engineers, Pittsburgh District.

12. "Hydraulics of Bridge Waterways," BPR, 1970, Discharge Coefficient Based on Criteria for Embankment Shaped Weirs, Figure 24, page 46.

13. Applied Hydraulics in Engineering, Morris, Henry M. and Wiggert, James N., Virginia Polytechnic Institute and State University, 2nd Edition, The Ronald Press Company, New York, 1972.

14. Standard Mathematical Tables, 21st Edition, The Chemical Rubber Company, 1973, page 15.

15. Engineering Field Manual, U. S. Department of Agriculture, Soil Conservation Service, 2nd Edition, Washington, D. C. 1969.

16. Water Resources Engineering, R. K. Linsley and J. B. Franzini, McGraw-Hill, Inc., New York, 1972.

17. Engineering for Dams, Volume 2, W. P. Creager, J. D. Justin, J. Hinds, John Wiley & Sons, Inc., New York, 1964.

APPENDIX D-1

STABILITY CALCULATIONS

JECT DAM SAFETY INSPECTION
HAWSTONE DAM

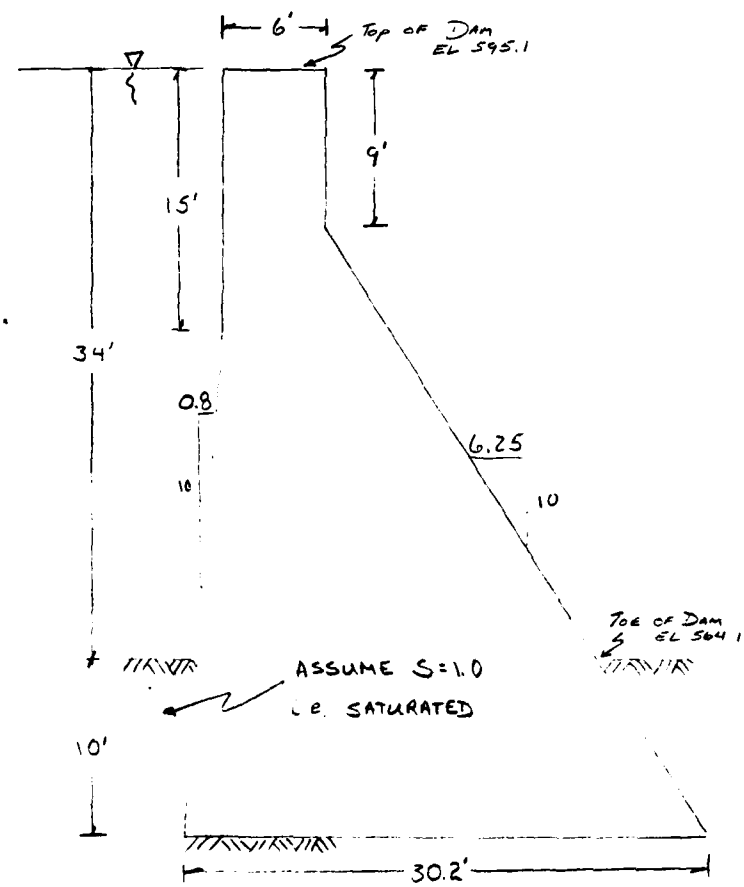
BY DLR DATE 1-11-80 PROJ. NO. 79-203-580

CHKD. BY EJM DATE 1-17-80 SHEET NO. 1 OF 6

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

STABILITY ANALYSIS

ANALYZE THE DAM CONSIDERING THE FOLLOWING SECTION.



SCALE 1" = 10'

ANALYSIS CONSIDERS POOL LEVEL AT TOP OF DAM.

FORCES INCLUDED IN THIS ANALYSIS ARE HYDROSTATIC PRESSURE, UPLIFT PRESSURE, AND WEIGHT OF DAM.

REF FIGURE 4 AND FIELD MEASUREMENTS (SEE NOTE 2, SHEET 2)

FORCES CONSIDERED, BUT NOT APPLIED TO THIS ANALYSIS INCLUDE WAVE PRESSURE, WIND PRESSURE, EARTHQUAKE FORCES, ICE PRESSURE, FOUNDATION RESISTANCES DUE TO TIES OR KEYS, AND EARTH PRESSURES (PARTICULARLY THE SHEAR STRENGTH OF ROCK AT THE TOE).

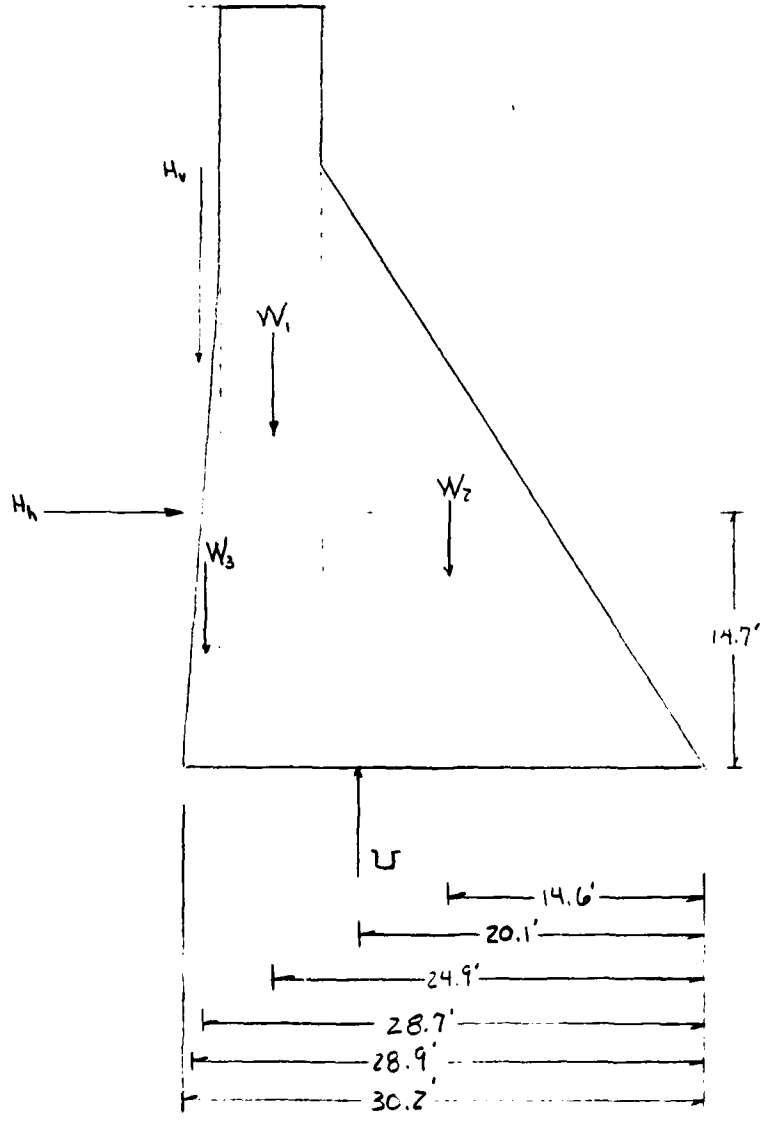
ECT DAM SAFETY INSPECTION
HAWSTONE DAM

BY DLB DATE 1-11-80 PROJ. NO. 79-203-580

CHKD. BY EJM DATE 1-17-80 SHEET NO. 2 OF 6

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

ANALYZE A 1-FOOT SECTION OF THE DAM. TAILWATER WILL NOT BE CONSIDERED DUE TO THE STEEPNESS OF THE VALLEY SLOPE AND THE FACT THAT THE SPILLWAY DISCHARGES SAFELY DOWNSTREAM.



JECT DAM SAFETY INSPECTION
HAWSTONE DAM

BY DLB DATE 1-11-80 PROJ. NO. 79-203-580

CHKD. BY EJM DATE 1-17-80 SHEET NO. 3 OF 6

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

HYDROSTATIC FORCE ON FACE OF DAM

$$H_H = \gamma\left[(1/2)(h)^2\right]T = (62.4\,PCF)\left[(1/2)(44\,FT)^2\right](1.0\,FT) =$$

60,400 Lbs

UPLIFT PRESSURE ON BASE OF DAM

$$U = \gamma\,(1/2)(h_1 + h_2)\,Tb = (62.4\,PCF)(1/2)(44\,FT + 0)(1.0\,FT)(30.2\,FT) =$$

41,460 Lbs

WEIGHT OF WATER ON UPSTREAM FACE

$$H_V = \gamma\left[(2.3\,FT)(15\,FT) + (1/2)(2.3\,FT)(29\,FT)\right](1.0\,FT) = \quad 4,230\ Lbs$$

WEIGHT OF DAM

$$W_1 = (150\,PCF)(1.0\,FT)(44\,FT)(6\,FT) = \quad 39,600\ Lbs$$

$$W_2 = (150\,PCF)(1.0\,FT)(1/2)(21.9\,FT)(35\,FT) \quad 57,490\ Lbs$$

$$W_3 = (150\,PCF)(1.0\,FT)(1/2)(29\,FT)(2.3\,FT) = \quad 5,000\ Lbs$$

ALL FORCES ACT AS SHOWN ON SHEET 13.

JECT DAM SAFETY INSPECTION
HAWSTONE DAM

BY DLB DATE 1-11-80 PROJ. NO. 79-203-580

CHKD. BY EJM DATE 1-17-80 SHEET NO. 4 OF 6

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

OVERTURNING

INDUCING MOMENTS

$M_1 = H_n(19.7\text{FT}) + U(20.1\text{FT}) =$ 1,721,230 Lb-FT

RESISTING MOMENTS

$M_2 = W_1(24.9\text{FT}) + W_2(14.6\text{FT}) + W_3(28.7\text{FT}) + H_v(28.9\text{FT}) =$

$= 986{,}040 + 839{,}350 + 143{,}500 + 122{,}250 =$ 2,091,140 Lb-FT

FACTOR OF SAFETY AGAINST OVERTURNING

$$F.S. = \frac{\text{RESISTING MOMENTS}}{\text{INDUCING MOMENTS}}$$

$$= \frac{2{,}091{,}140 \text{ Lb-FT}}{1{,}721{,}230 \text{ Lb-FT}} = 1.2$$

SLIDING

INDUCING FORCE

$H_n = 60{,}400$ Lbs

RESISTING FORCE

$F_f = \mu(W_t - U + H_v)$

IECT DAM SAFETY INSPECTION
HAWSTONE DAM

BY DLB DATE 1-11-80 PROJ. NO. 79-203-580

CHKD. BY EJM DATE 1-17-80 SHEET NO. 5 OF 6

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

μ = FRICTION FACTOR = 0.67 (AS PER DESIGN CALCS CONTAINED IN PENNDER FILES)

W_T = TOTAL WEIGHT OF CONCRETE
= $W_1 + W_2 + W_3 = 39,600 + 57,490 + 5000$ = 102,090 Lbs

U = UPLIFT FORCE = 41,460 Lbs

$F_f = (0.67)(102,090 - 41,460 + 4230)_{Lbs}$ 43,460 Lbs

FACTOR OF SAFETY AGAINST SLIDING

$$F.S. = \frac{\text{RESISTING FORCE}}{\text{INDUCING FORCE}} = \frac{43,460 \text{ Lbs}}{60,400 \text{ Lbs}} = 0.7$$

THE ABOVE CALCULATED SAFETY FACTORS FOR SLIDING (0.7) AND OVERTURING (1.2) DO NOT COMPARE FAVORABLY WITH GENERALLY ACCEPTED FACTORS OF 1.0 TO 1.5 FOR SLIDING AND ABOUT 2.0 FOR OVERTURING (REF 16, pg 200).

ORIGINAL DESIGN DATA CONTAINED IN PENNDER FILES INDICATES THAT THE DESIGNER DID NOT CONSIDER UPLIFT PRESSURES EXERTED ON THE BASE OF THE STRUCTURE. THE REASONING BEHIND THIS DELETION IS UNCLEAR. THE RESULT OF ALLOWING U TO APPROACH ZERO IS PRESENTED ON THE FOLLOWING PAGE.

PROJECT DAM SAFETY INSPECTION
HAWSTONE DAM

BY DLB DATE 1-11-80 PROJ. NO. 79-203-580

CHKD. BY EJM DATE 1-17-80 SHEET NO. 6 OF 6

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

OVERTURNING ($U \rightarrow 0$)

INDUCING MOMENTS

$M_1 = H_h (19.7 FT) =$ 887,880 Lb-FT

RESISTING MOMENTS

$M_2 =$ 2,091,140 Lb-FT

$$F.S. = \frac{M_2}{M_1} = \frac{2,091,140 \text{ Lb-FT}}{887,880 \text{ Lb-FT}} = 2.4$$

SLIDING ($U \rightarrow 0$)

INDUCING FORCE

$H_h = 60,400$ Lbs

RESISTING FORCE

$F_f = \mu (W_T + H_v) = (0.67)(102,090 + 4230)$ Lbs $= 71,230$ Lbs

$$F.S. = \frac{F_f}{H_h} = \frac{71,230 \text{ Lbs}}{60,400 \text{ Lbs}} = 1.2$$

APPENDIX E

FIGURES

LIST OF FIGURES

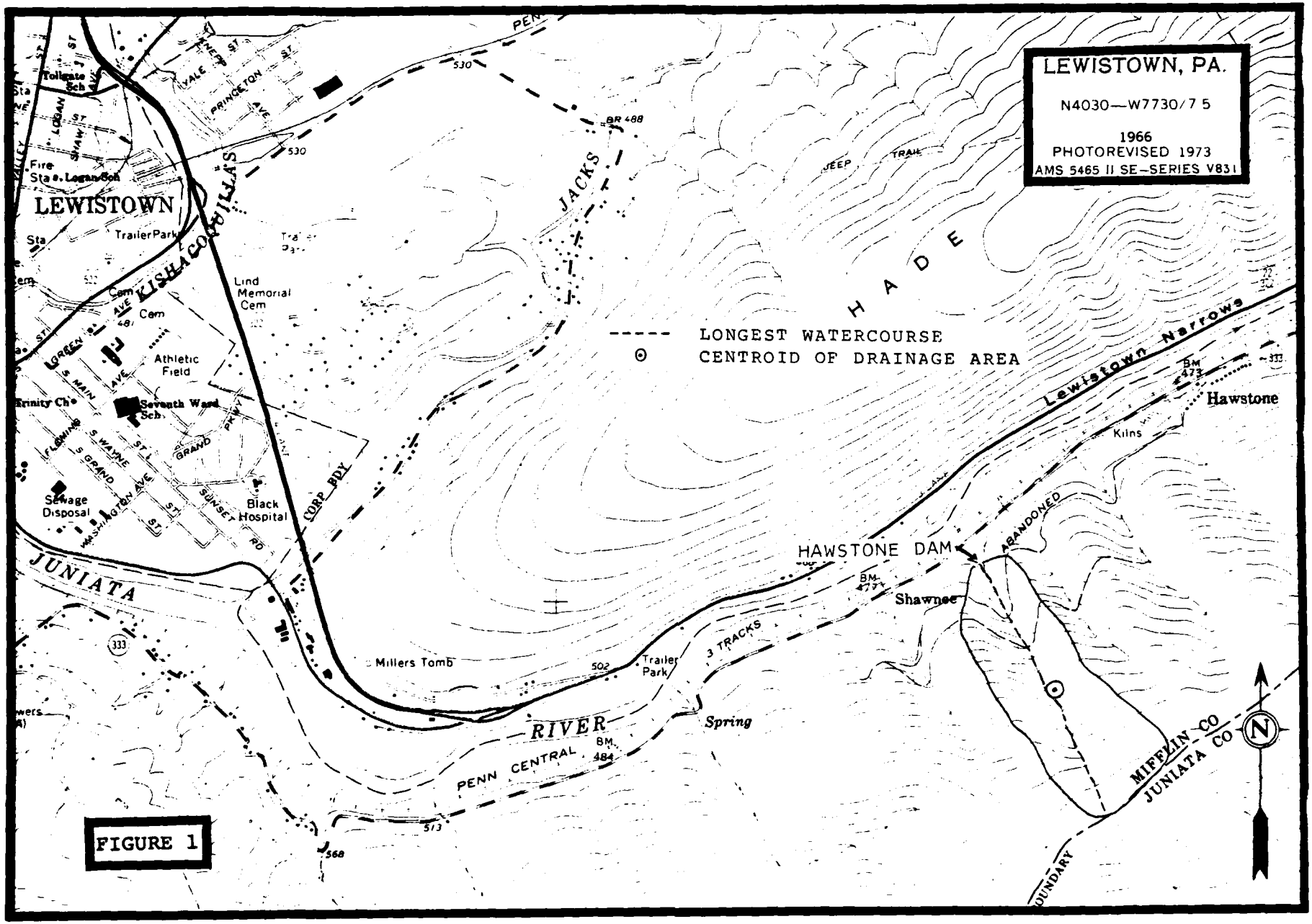
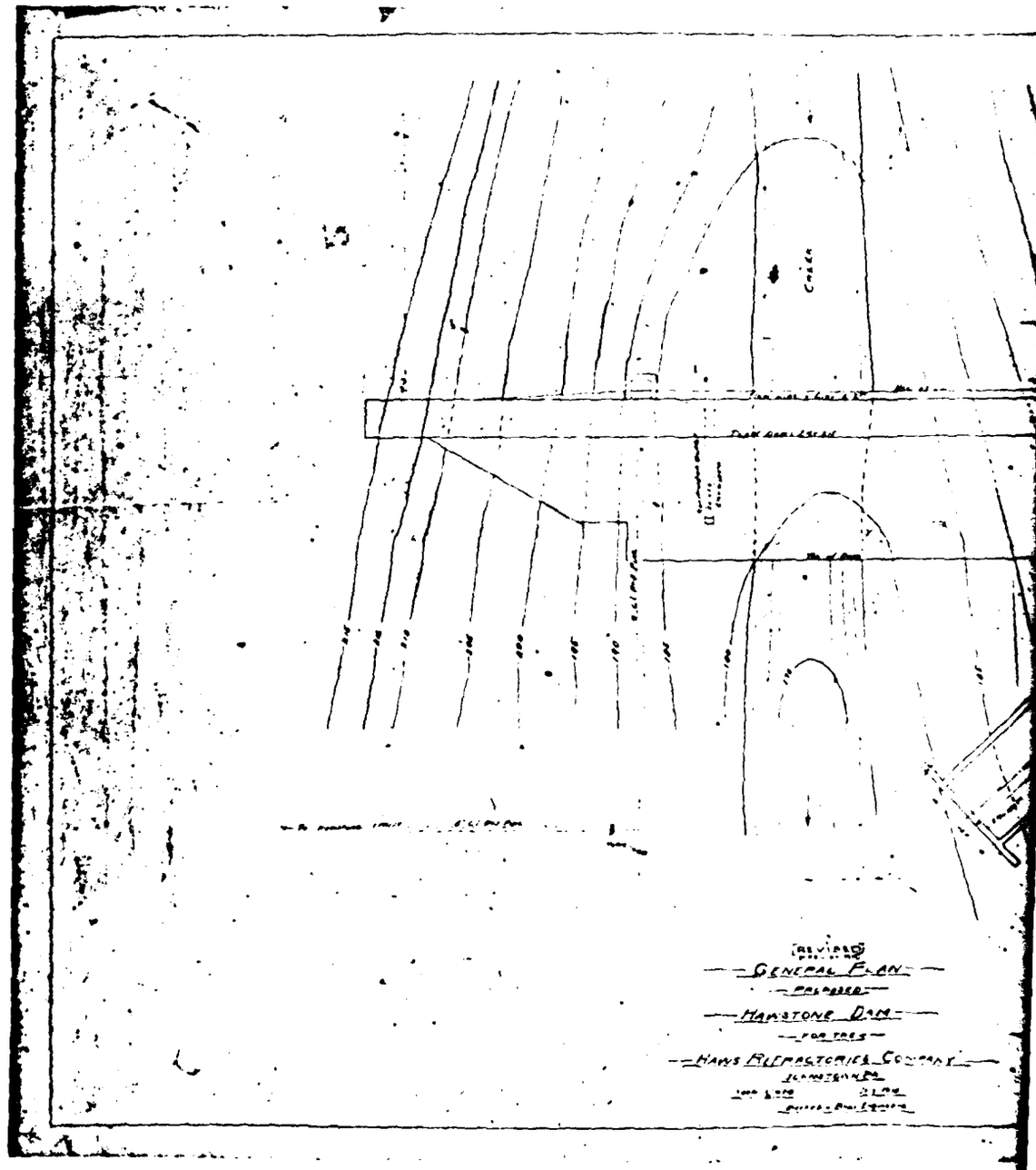
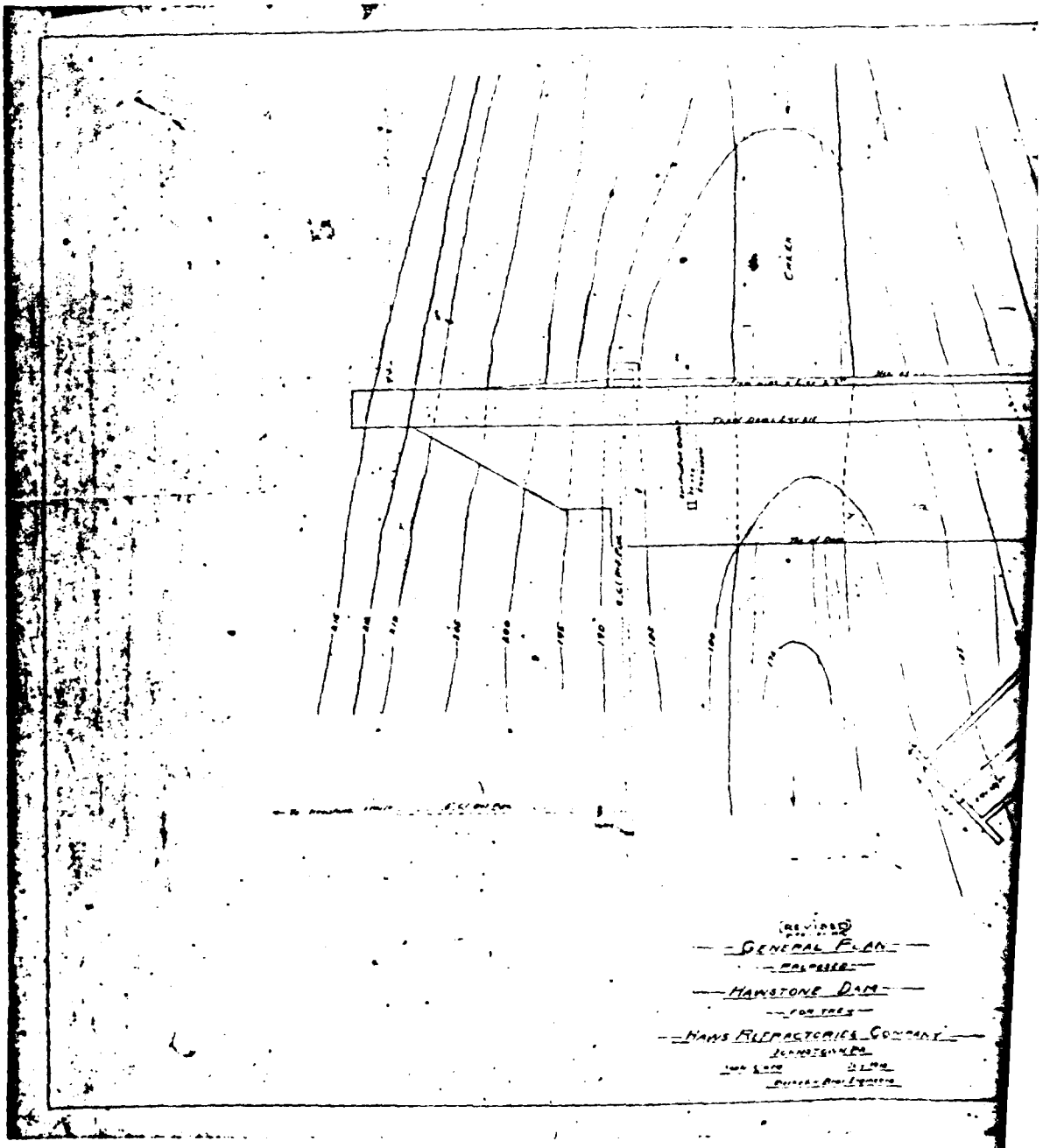
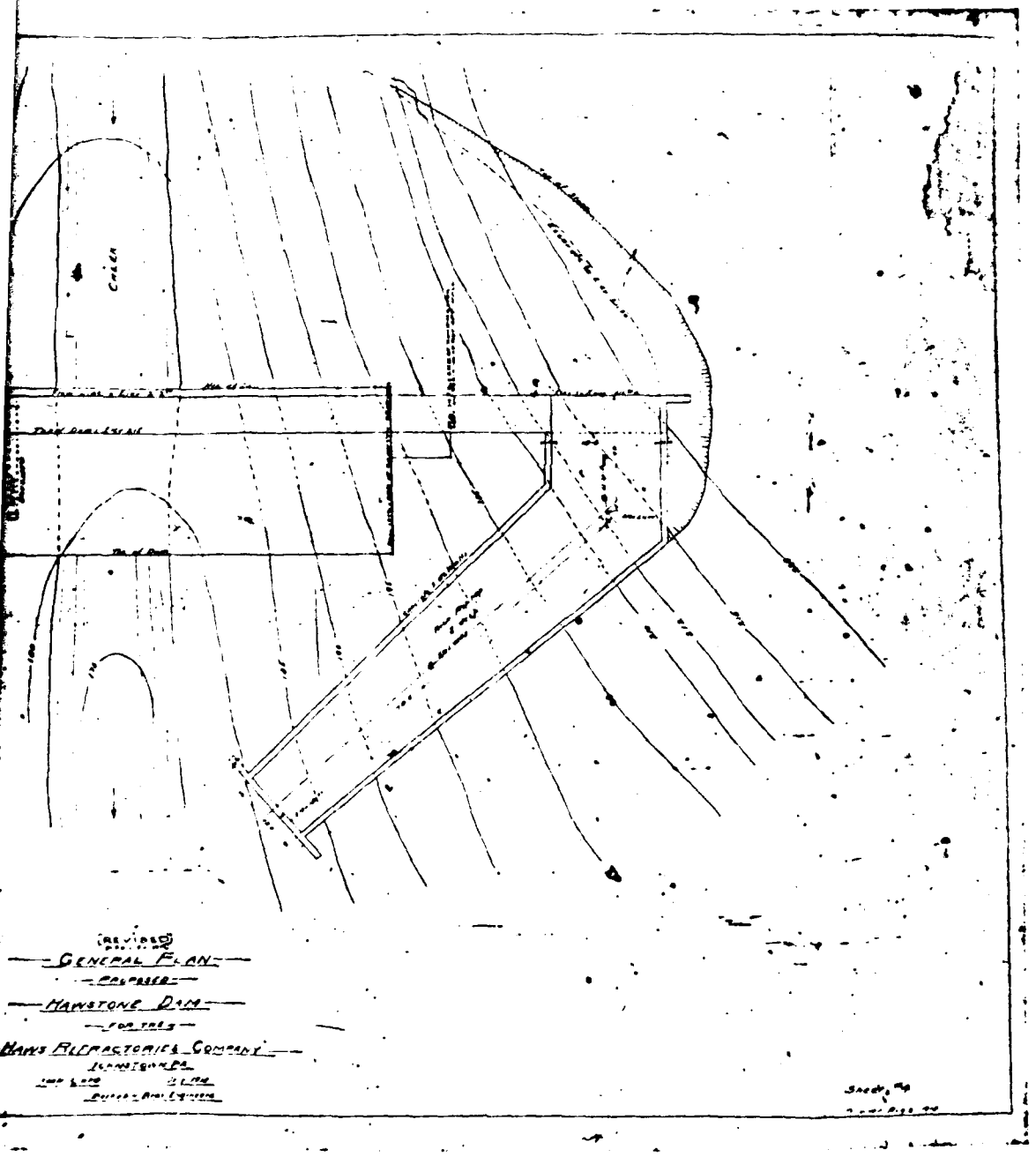

LEWISTOWN, PA.
N4030—W7730/7 5
1966
PHOTOREVISED 1973
AMS 5465 II SE—SERIES V831
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
LEWISTOWN
KISHACOQUILLAS
JACKS
HADE
Lewistown Narrows
Hawstone
Kilns
HAWSTONE DAM
ABANDONED
Shawnee
JUNIATA
RIVER
PENN CENTRAL
3 TRACKS
Millers Tomb
Spring
Trailer Park
Athletic Field
Lind Memorial Cem
Seventh Ward Sch
Black Hospital
Sewage Disposal
Tolligate Sch
Fire Sta
Trinity Ch
CORP PDY
JEEP TRAIL
MIFFLIN CO
JUNIATA CO
BOUNDARY
BM 473
BM 477
BM 484
BR 488
530
502
573
568
333
N

FIGURE 1

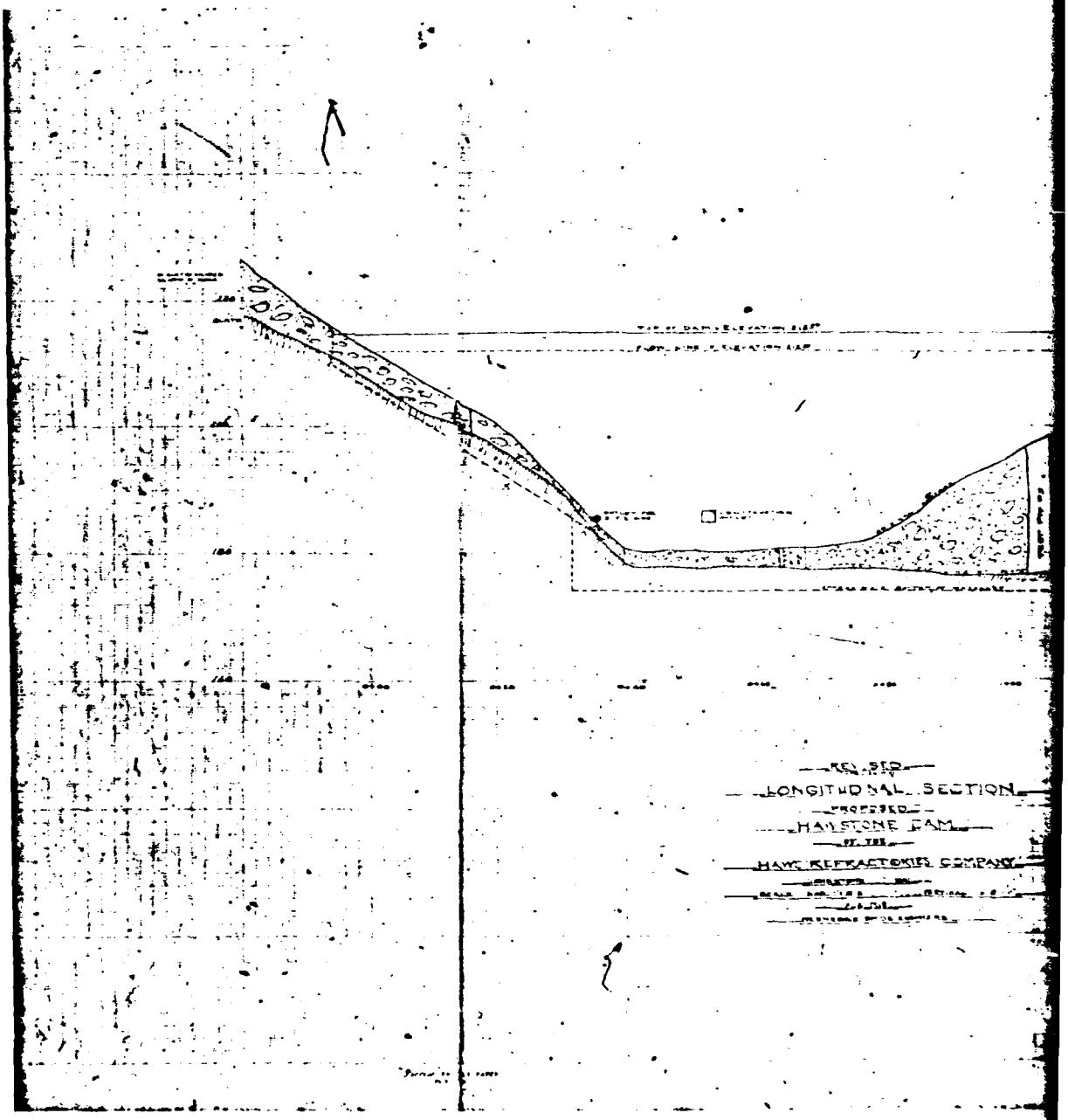

CREEK
REVISED
GENERAL PLAN
PROPOSED
HAMSTONE DAM
FOR THE
HAWS REFRACTORIES COMPANY


CREEK
DAM DIRECTION
(REVISED)
GENERAL PLAN
OF
HAWSTONE DAM
FOR THE
HAWS REFRACTORIES COMPANY

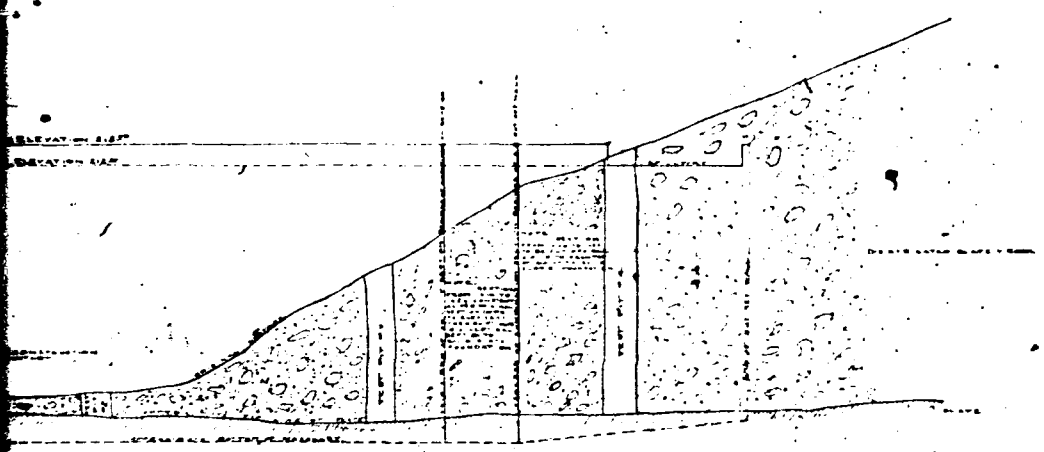


GAI CONSULTANTS, INC.

FIGURE 2



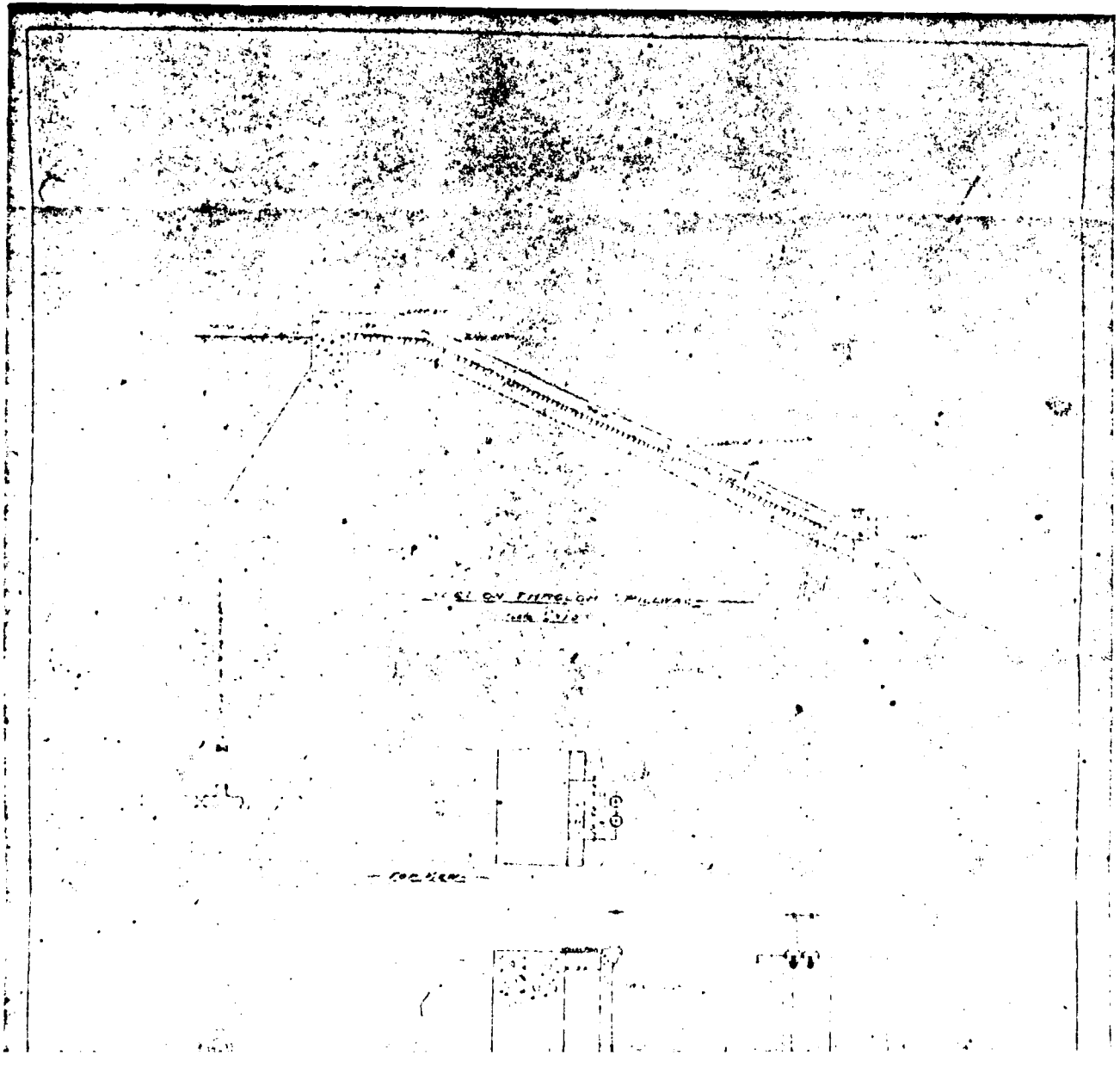
REVISED
LONGITUDINAL SECTION
PROPOSED
HAILSTONE DAM
OF THE
HAWK REFRACTORIES COMPANY

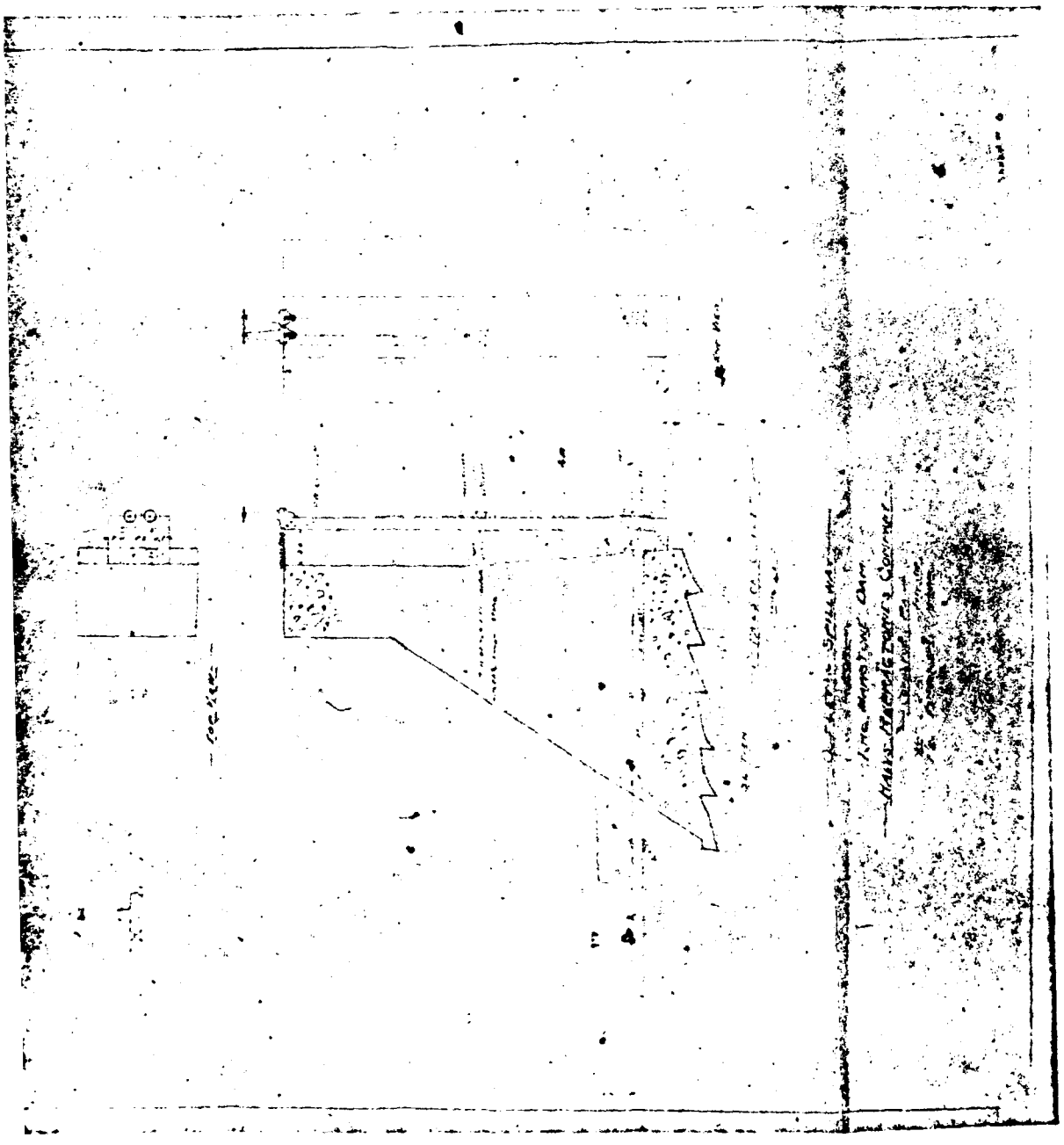


REVISED
LONGITUDINAL SECTION
PROPOSED
HAYSTONE DAM
OF THE
HAWS REFRACTORIES COMPANY

GAI CONSULTANTS, INC.

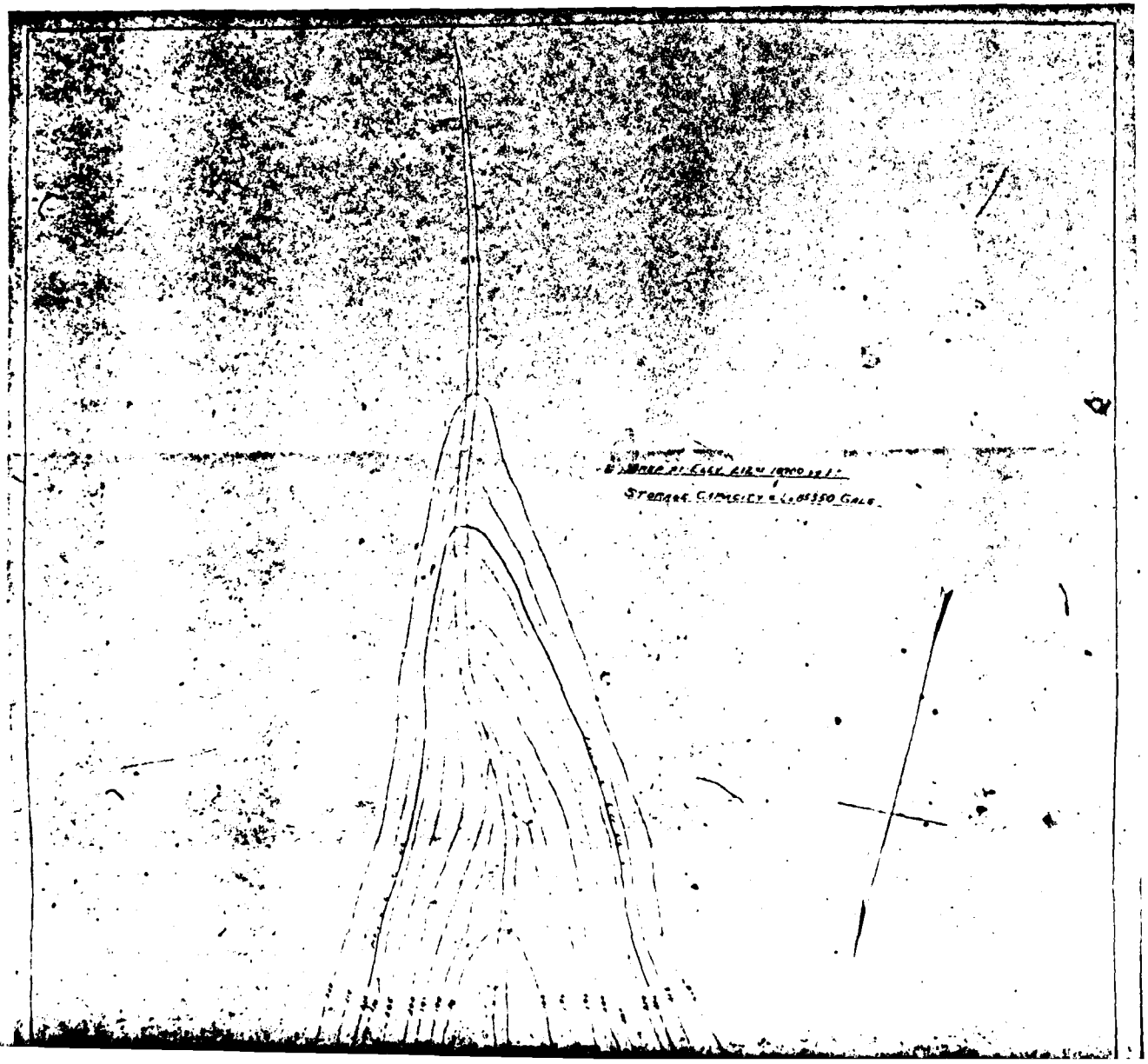
FIGURE 3

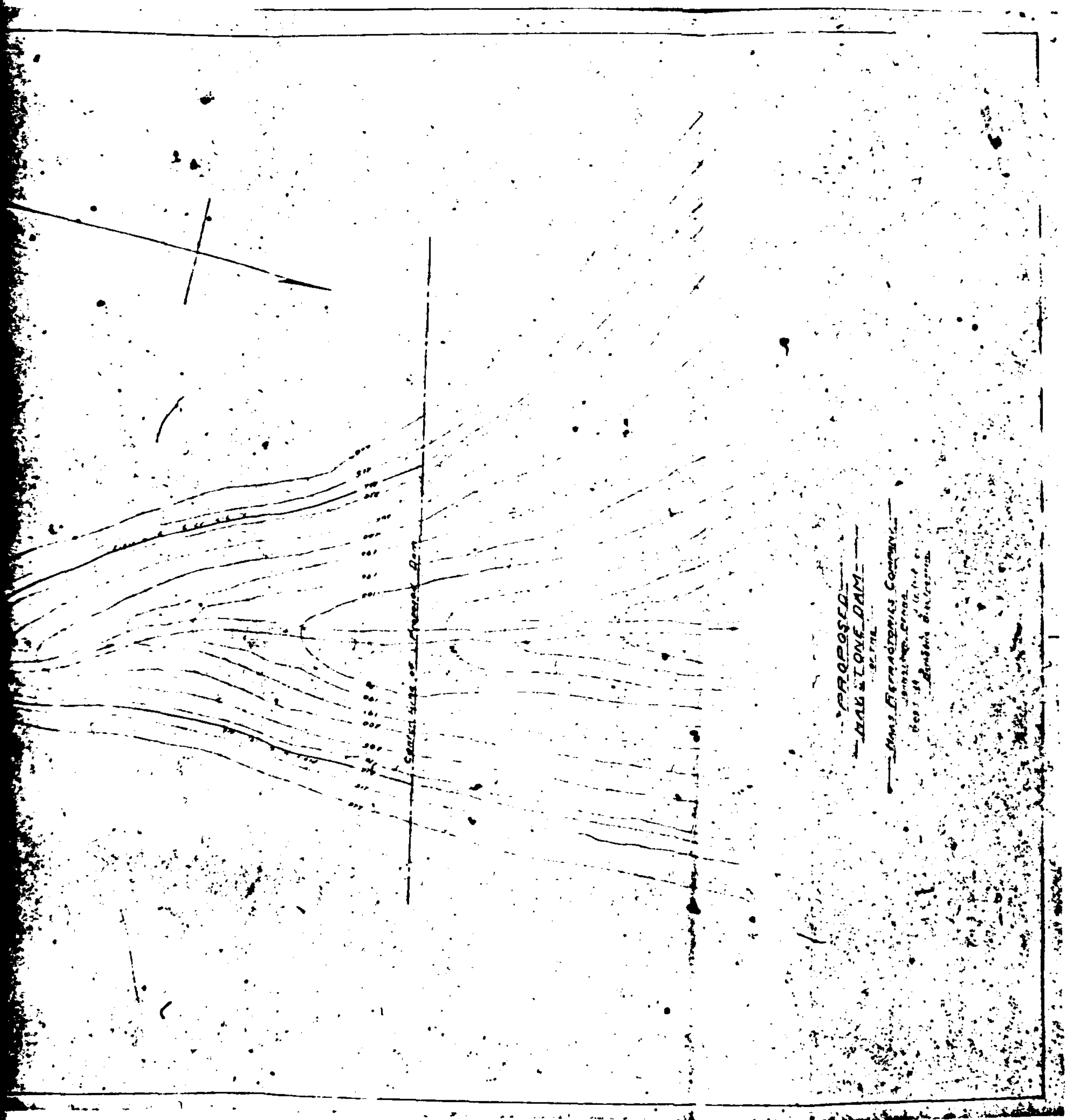




GAI CONSULTANTS, INC.

FIGURE 4


STORAGE CAPACITY = 1,085350 GALS



CONSULTANTS, INC.

FIGURE 5

APPENDIX F

GEOLOGY

Geology

Hawstone Dam is located about 1 mile west of Hawstone, Pennsylvania on an unnamed tributary to the Juniata River, in the Valley and Ridge physiographic province of the Appalachian Mountain Section of central Pennsylvania. This tributary is located on the northwest flank of Blue Mountain which rises approximately 1,400 feet to the southeast above the dam.

Structurally, the dam lies in the Lewistown Narrows of the Lewistown Valley synclinorium, a major northeast-southwest trending structure that can be traced for nearly 40 miles. In the Lewistown area, folding generally increases in intensity producing a complex group of northeast-southwest trending folds. Many of the component folds, especially along the southern flank of the synclinorium, are plunging. There is little evidence of major faulting in the vicinity of the dam.

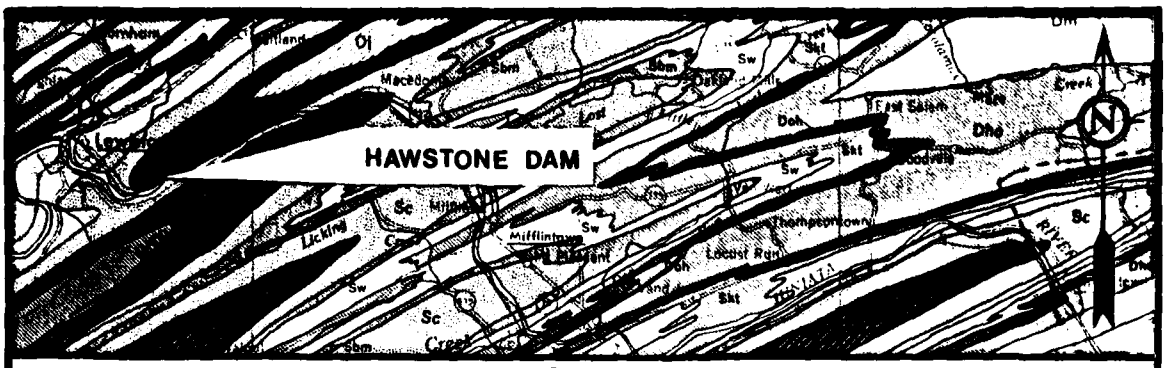
At the dam site, the bedrock dips away from the downstream face of the dam at nearly 80 degrees, while the strike is approximately parallel with the dam axis. The bedrock immediately underlying the dam and reservoir consists of a Silurian age shale probably representing the Clinton Group. This thinly bedded shale is reddish-purple to greenish-gray in color and is interfingered with "iron sandstone" and local gray, fossiliferous limestone. Above

the dam lies a quartzitic sandstone, probably representing the Tuscarora formation, which is of some economic importance and has been locally quarried.

---

[1]Colin, Richard R. and Hoskins, Donald M., "Geology and Mineral Resources of the Mifflintown Quadrangle Pennsylvania," Pennsylvania Geological Survey, Fourth Series, ATLAS A 126, 1962.

[2]Lohman, Stanley W., "Groundwater in South Central Pennsylvania," Pennsylvania Geological Survey, Fourth Series, Bulletin W5, 1938.



LEGEND

DEVONIAN

Dck — Catskill Formation
Chiefly red to brownish shales and sandstones; includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east.

Dm — Marine beds
Gray to olive brown shales, graywackes, and sandstones; contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock. Tully Limestone at base.

MIDDLE AND LOWER

Dmk — Mahantango Formation
Brown to olive shale with interbedded sandstones which are dominant in places (Montebello); highly fossiliferous in upper part; contains "Centerfield coral bed" in eastern Pennsylvania.

Dmk — Marcellus Formation
Black, fissile, carbonaceous shale with thick, brown sandstone (Turkey Ridge) in parts of central Pennsylvania.

Onondaga Formation
Greenish blue, thin bedded shale and dark blue to black, medium bedded limestone with shale predominant in most places; includes Selinsgrove Limestone and Needmore Shale in central Pennsylvania and Buttermilk Falls Limestone and Esopus Shale in easternmost Pennsylvania; in Lehigh Gap area includes Palmerton Sandstone and Bowmanstown Chert.

Oriskany Formation
White to brown, fine to course grained, partly calcareous, locally conglomeratic, fossiliferous sandstone (Ridgeley) at the top; dark gray, cherty limestone with some interbedded shales and sandstones below (Shriver).

Helderberg Formation
Dark gray, calcareous, thin bedded shale (Mandata) at the top, equivalent to Port Ewen Shale and Becraft Limestone in the east, dark gray, cherty, thin bedded, fossiliferous limestone (New Scotland) with some local sandstones in the middle; and, at the base, dark gray, medium to thick bedded, crystalline limestone (Coeymans), sandy and shaly in places with some chert nodules.

SILURIAN

Keyser Formation
Dark gray, highly fossiliferous, thick bedded, crystalline to nodular limestone; passes into Manlius, Rondout, and Decker Formations in the east.

Skt — Tonoloway Formation
Gray, highly laminated, thin bedded, argillaceous limestone; passes into Bossardville and Pozono Island beds in the east.

Skm

Sw — Wills Creek Formation
Greenish gray, thin bedded, fissile shale with local limestone and sandstone zones; contains red shale and siltstone in the lower part.

Bloomsburg Formation
Red, thin and thick bedded shale and siltstone with local units of sandstone and thin impure limestone, some green shale in places

Sc — Clinton Group
Predominantly Rose Hill Formation - Reddish purple to greenish gray, thin to medium bedded, fossiliferous shale with interfonguing "iron sandstones" and local gray, fossiliferous limestone; above the Rose Hill is brown to white quartzitic sandstone (Keefer) interbedded upward with dark gray shale (Rochester).

Tuscarora Formation
White to gray, medium to thick bedded, fine grained, quartzitic sandstone, conglomeratic in part.

ORDOVICIAN

Oj — Juniata Formation
Red, fine grained to conglomeratic, quartzitic sandstone with well developed cross-bedding and with interbedded red shale in places.

Bald Eagle Formation
Gray to greenish gray, fine grained to conglomeratic, thick bedded sandstone, often iron-speckled and cross-bedded; some greenish gray shale in places.

Scale

0 2 4 6 8 10 MILES

GEOLOGY MAP

REFERENCE:
GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA, DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

GAI CONSULTANTS, INC.